NATURE

No. 4065 SATURDAY, SEPTEMBER 27, 1947 Vol. 160

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Telegrams: Phusis Lesquare London
Advertisements should be addressed to
T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2
Telephone: Temple Bar 1942
The annual subscription rate is £4 10 0, payable in advance, inland or Abroad

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FREEDOM OF THE PRESS

TWO recent publications, namely, a book by Mr. Kingsley Martin published in Great Britain*, and a General Report by the Commission on Freedom of the Press prepared in the United States†, are devoted to consideration of the freedom of the Press, using that term in its wide sense. Both state clearly the issues involved and in such a way that there can be no mistaking the implications in the scientific field. The American report, for example, emphasizes the way in which freedom of expression tends to lift the level of social conflict from the plane of violence to that of discussion: it is part, in fact, of the method of democracy as of science, and the effective agencies for safeguarding it are the community and the Government; of these two, Government, through its elementary responsibility for maintaining order and personal security, comes first. We must also face frankly the fact that freedom of the Press is dangerous and open to abuse, just because it makes high demands on reasonableness in the public mind; equally we must recognize that the very power of Government to secure freedom of expression involves the possibility of infringement.

The American Commission stresses, therefore, that if freedom of the Press is to be real, Government must set limits upon its own capacity to interfere with the Press or to manipulate the data on which public judgment is formed. It is the mark of a free society that in it the Government does expressly limit its scope of action in regard to certain human liberties which are not only important interests but also moral rights, and of these freedom of expression is one. Such moral rights are not, however, unconditional, and the report does well to stress the element of responsibility which is inseparably built into any such moral right. That element does not, it is true, exclude the possibility of error. Liberty to experiment and, by implication, trial and error, involve the possibility of wrong opinions or false conclusions. What is excluded is the right to be deliberately or irresponsibly in error.

Again, abuse of a right does not *ipso facto* lead to forfeit of the protection it affords, although there are limits to the legal toleration of abuse of freedom of expression. Such limits are based on the common principle that utterance or publication must not invade in a demonstrable manner recognized private rights or vital social interests. Moreover, a further question of public responsibility arises to-day in view of the extent to which public interest affects the functions of the Press, and the American Commission urges that the Press must now assume as its own objectives those of the community for the Press. It recognizes an antithesis between the current conception of the freedom of the Press and its accountability, and points out that the Press must recognize that its faults and errors have ceased to be private vagaries and have become public dangers. The Press

* The Press the Public Wants. By Kingsley Martin. Pp. 143. (London: Hogarth Press, 1947.) 7s. 6d. net.

† A Free and Responsible Press. A General Report on Mass Communication: Newspapers, Radio, Motion Pictures, Magazines and Books. By the Commission on Freedom of the Press. Pp. xii+139 (Chicago: University of Chicago Press; London: Cambridge University Press, 1947.) $2 dollars.

must accept the public standard and endeavour to achieve it.

The conception of freedom of the Press brought out in this report is that of freedom from compulsions from any sources, though not from pressures. It implies also a Press free for the expression of opinion in all its phases, and free also to achieve the goals of service in which its own ideals and the requirements of the community combine and which existing techniques make possible. It means also a Press free to all who have something worth saying to the public.

The specific recommendations which the Commission makes to further this ideal fall into three groups. First, a Government may improve the conditions under which Press activities function, so that the public interest is better served, by improving distribution, removing hindrances to the free flow of ideas, reducing confusion and promoting the reality of public debate. It is because of the grave handicap which they impose on public debate and the effective distribution of news and comment that the latest cuts in newsprint are so deplorable, above all at a time when on the international plane the United Nations Educational, Scientific and Cultural Organisation is attempting to improve conditions in just the way suggested. Furthermore, it is suggested that Government should enter the field of Press comment and news supply, not as displacing private enterprise, but as a supplementary service, which may even present standards for emulation.

In making this general recommendation, the Commission has particularly in mind the introduction of new techniques, and reflects also the American dislike of trusts, though it is suggested that to maintain competition the anti-trust laws should only be sparingly invoked. It recommends that the constitutional guarantees of the freedom of the Press be recognized as including the radio and the cinema film.

The second group of recommendations relates to action by the Press itself. These include the acceptance of its responsibility as a common carrier of information and discussion, and the assumption of the responsibility of financing new experimental activities in the different fields of mass communication. Vigorous mutual self-criticism by members of the Press and the use of every possible means of increasing the competence, independence and effectiveness of staff are also recommended, and finally, that the radio industry should control its programmes and treat advertising as it is treated by the best newspapers.

The third group of three recommendations relates to action calling for public initiative and pre-supposing recognition of the vital importance of the Press. First of these is the use of non-profit institutions to help to supply the variety, quantity and quality of the Press required. Next comes the creation of academic centres of advanced study, research and publication in the field of communications, as well as the co-operation of existing schools of journalism with the universities to give their students the broadest and most liberal training. Finally, the Commission recommends the establishment of a new and independent agency to appraise and report annually on the performance of the Press. The activities of this agency are also outlined; but although they include the encouragement of the establishment of centres of advanced study, research, and criticism in the field of communications at universities, it is difficult to believe that much support would be forthcoming for the establishment of such an agency in Great Britain. The need for centres of investigation, graduate study and critical publication may be admitted, though it might well be a field in which the initiative, if not the organisation, should come from the United Nations Educational, Scientific and Cultural Organisation. Such studies and research might well be planned internationally even if carried out in national institutions.

It is to the cumulative effect of these recommendations rather than to any one, or any group, of them that the Commission looks to bring the performance of the Press closer to meeting the ideal demanded by society for the communication of news and ideas: a truthful, comprehensive and intelligent account of the day's events in a context which gives them meaning; a forum for the exchange of comment and criticism; the projection of a representative picture of the constituent groups in the society; the presentation and clarification of the goals and values of the society; and full access to the day's intelligence. That ideal is also formulated very clearly in Mr. Kingsley Martin's book, as indeed it was by Mr. Francis Williams in his "Parliament, Press and People" last year; though possibly Mr. Kingsley Martin sets out more clearly the limitations imposed by the state of the public mind. He recognizes that we cannot ignore the fact that comparatively few people have a passion for truth as a principle, or care about public events continuously when these do not obviously affect their own lives, and even the scientific worker with his disinterested desire for knowledge in his particular field may not apply the discipline of the laboratory to his political thinking.

Mr. Kingsley Martin covers a more limited field than did Mr. Williams, and his historical and critical chapters are excellent and apposite. Like the American Commission, he defines clearly the central problem of combining responsibility with freedom; but when he comes in his concluding chapters to "The Public Concern" and "Public Opinion in One World", he is diffident and less sure of himself. Three lines of advance, indeed, he points out, two of which are noted by the American Commission: the media of mass communications must become increasingly public concerns; our educational system must be better devised to create a conscious citizenship; and we must be given more chance to play an active part in the community life around us which we understand.

Mr. Kingsley Martin reviews succinctly the various suggestions that have been made for increasing the responsibility of the Press without endangering its freedom of presentation of news and comment, but without lending emphatic support to any. The main emphasis is laid on safeguarding the freedom of the journalist by raising his professional status and on guaranteeing the independence of the editor. He

insists, too, that hope of a public which can judge political issues and steadily demand—and, therefore, in the long run obtain—a better news service and a more informed type of comment, depends on the educational system, which must deliberately aim at the substitution of knowledge for prejudice in public affairs and the cultivation of the type of critical and informed mind which can apply itself to life as a whole and not only to specialized interests.

While Mr. Kingsley Martin, like the American Commission, emphasizes the professional contribution of the journalist, what he has to say about the importance of the local community and the business or professional association should be noted. He seems to be expressing much the same idea that Sir Alexander Carr-Saunders and Mr. P. A. Wilson voiced in their study of the professions, of the professional men finding in their vocational associations the permanent anchorage and shelter from which they could set out to shape organisations into instruments for the fulfilment of their purposes. It has its message for scientific men in particular as they face in the narrower field of scientific communications whatever dangers may be involved in the infection of Governments with the idea of military secrecy.

There is, as Mr. Kingsley Martin points out, an ever widening demand which increased secondary education has already evoked for news and comment which is independent of the control of the great proprietors owning most of the daily newspapers. The growth of a critical public is a hopeful sign, though the importance of this factor should not be exaggerated.

Both Mr. Kingsley Martin's book and the American report should help to clarify the confused thinking about public responsibility on the part of the Press which found reflexion in the establishment of a Royal Commission, and equally on the Government's disregard of public responsibility both in the ban on periodicals last winter and in the recent cuts in newsprint. The Government may not desire to suppress free comment; nevertheless, it can be accused of indifference to the importance of free comment and discussion. Both the publications under discussion should make an important contribution to the creation of that informed and alert public opinion on which in the last resort scientific workers themselves must rely for preservation of freedom of communication and public discussion.

WHITEHEAD'S COLLECTED ESSAYS

Essays in Science and Philosophy

By Alfred North Whitehead. Pp. vii+348. (New York: Philosophical Library, Inc., 1947.) 4.75 dollars.

IT was a happy idea to collect in one volume the occasional writings which Whitehead has produced from time to time in magazines and such-like places. How far the present assembly is complete is not stated; and if it is incomplete, there is no indication as to whether the choice of what should be included was made by Whitehead himself or by an editor.

The first part of the book is labelled "Personal", and consists for the most part of descriptions, intended for the information of American readers, of the author's boyhood environment in north-east Kent. They make pleasant armchair reading, enlivened by stories such as that of a neighbouring High-Church clergyman, who "introduced an altar cloth with the sacred monogram which can be read as the Latin capital letters I.H.S. This aroused some Protestant feeling, which was allayed only by the happy conjecture that the letters stood for Jenkins, Harvey and Snowden—the surnames of the vicar and his two curates." There is not as much as one would like about Whitehead's intellectual development: he tells us that his first great work, the "Universal Algebra", was inspired by Grossmann's "Ausdehnungslehre", Hamilton's "Quaternions" and Boole's "Symbolic Logic" (but this has always been evident); and we learn that he could never read Hegel. The ending of his long and marvellously fruitful partnership with Bertrand Russell is briefly referred to in the words: "Our fundamental points of view—philosophic and sociological—diverged, and so with different interests our collaboration came to a natural end".

The more serious part of the book begins with an essay on "Immortality", written in 1941 and already familiar to many readers from its inclusion in the Whitehead volume of the "Library of Living Philosophers". The main thesis in this paper is that we naturally simplify the complexity of the universe by considering it in the guise of two abstractions, namely, the world of activity and the world of value. The prime characteristic of the one world is change, and of the other world is immortality. Each of these worlds is futile except in its function of embodying the other—value refers to fact, and fact refers to value. Either world can be described only in terms of factors which are common to both of them: such factors have a dual aspect, and each world emphasizes one of the two aspects: the factors are no other than the Platonic "Ideas". A key example for understanding the fusion of the world of activity and the world of value is the problem of "personal identity" in a changing world of occasions: here the immortality which belongs to value has entered into the changefulness which is the essential character of activity.

The world of value exhibits the essential oneness of the universe. Thus while it brings into view the immortal side of the many persons, it also involves the integration of personality. This is identified by Whitehead with the concept of God, who is the intangible fact at the base of finite existence, a unification founded on ideals of perfection, moral and aesthetic; to ascribe arbitrary power to Him is a profanation. Clearly this is not the God of the Christian theological tradition, nor is it the diffused God of the Hindu-Buddhistic tradition; the concept lies somewhere between the two.

An article on "Analysis of Meaning", reprinted from the *Philosophical Review* of 1937, contains a remarkable suggestion with regard to the prospects of the author's favourite study, symbolic logic. When in the distant future the subject has expanded, so as to examine patterns depending on connexions other than those of space, number and quantity, then, Whitehead suggests, symbolic logic (that is to say, the symbolic examination of patterns with the use of real variables) will become the foundation of aesthetics; and from that stage he anticipates that it will proceed to conquer ethics and theology.

The next group of essays is concerned with education, and sparkles with Whiteheadian apophthegms: "Modern thought was not introduced into the educational curriculum, but merely modern technique"; "Logic is the chosen resort of clear-headed people, severally convinced of the complete adequacy of their doctrines. It is a pity that they cannot agree with each other"; "What is the use of a vague remembrance of the wrong date for the last glacial epoch?"; "Unless we are careful, we shall organise genius out of existence".

There are also sound maxims: "The function of the study of a subject is not so much to produce knowledge as to form habits"; "The main structure of successful education is formed out of the accurate accomplishment of a succession of detailed tasks".

The most striking of Whitehead's proposals is that half the teaching of modern history should be handed over to the mathematicians. The phrase "handed over" is perhaps not quite accurate, for the half referred to is at present scarcely taught. The professed teachers of history are in many cases not fitted to appreciate quantitative estimates of the forces that are moulding society; but the quantitative approach is now readily practicable. There are to our hands statistics of internal and external trade, of employment, of production, of prices, of national income and expenditure, of health, of education, of crime, and so forth. The reduction of these to graphs, the careful study of the peculiarities of these graphs, the search for correlations among them, and the reference to the public events which corresponded in time to peculiarities in graphical form, would teach more knowledge of modern social forces and even of international relations than all other methods put together, and incidentally would provide an excellent training in mathematics. Problems could be set for solution by the pupils, such as to trace the effect of war on the social life of a nation as exhibited by the graphs.

The last section of the volume is devoted to pure science. An article written in 1934 and now reprinted from *Mind*, on "Indication, Classes, Numbers, Validation", is of great value and supplements "Principia Mathematica" in some important respects. The concluding essay is a criticism of Einstein's General Relativity, originally published in *The Times Educational Supplement* in 1920, when the theory was only beginning to be widely known in Great Britain. Whitehead's main point is stated thus: "We cannot begin to measure in space until we have determined a non-metrical geometry and have utilised it to assign the conditions of congruence agreeing with our sensible experience. Practical measurement merely requires practical conformity to definite conditions. The theoretical analysis of the practice requires the theoretical geometric basis. For this reason I doubt the possibility of measurement in space which is heterogeneous as to its properties in different parts. I do not understand how the fixed conditions for measurement are to be obtained. In other words, I do not see how there can be definite rules of congruence applicable under all circumstances." Whitehead followed up this idea at the time by devising an alternative form of General Relativity which assumed uniform space as a basis. This, however, was not widely accepted, and the researches of Levi-Civitá and others on the operations required to determine the gravitational potentials have been generally regarded as meeting the objections to Einstein's theory.

EDMUND WHITTAKER

PLANT COVER OF THE MEDITERRANEAN REGION

Das Pflanzenkleid der Mittelmeerländer

By Prof. Dr. M. Rikli. 2 vols. Pp. xvi+xv+1,093+189 plates. (Bern: Hans Huber, 1943 and 1946.) 94 Schw. francs.

VOLUME 1 of Dr. Rikli's book on the plant cover of the Mediterranean region, which originally appeared in parts in 1942 and 1943, is now published in book form (see *Nature*, **152**, 117 (1943), and **153**, 445 (1944)).

Volume 2 completes the work, with the exception only of the list of literature and index, which are to appear in a separately published appendix in order to avoid overloading the second volume. As in the first volume, the subject is exhaustively treated, and the mass of information presented is illustrated by maps and excellent photographs. Chapter 8 is terminated with a description of the third of the altitude lines or vegetation belts distinguished by the author, namely, the orophytia belt or that of subalpine communities. The remaining chapters contain respectively regional accounts of the mountain flora; a description of the cultivated lands, with information on the plants introduced by man from the days of Alexander the Great onwards; accounts of the border regions or steppes and steppe deserts and subtropical primeval forest areas, with special reference to the conditions underlying the different types of plant cover; and contributions to the plant geography of the region, treating surveys and statistics, invasions and pseudo-invasions from north, west, south and east, and invasions from great distances. Finally, the whole work is summarized in a chapter which discusses first the Mediterranean basin in relation to its environment; then the Mediterranean region as a unit, and its main divisions; thirdly, exceptional areas such as Portugal, the pluvial regions, north Cyrenaica and others; and lastly the mountain flora.

The twenty-eight individual examples of mountain flora which are described in the ninth chapter, several of them contributed by other authors, are representative in that they are taken from widely separated parts of the region. The areas studied range in altitude from 412 m. (Mt. Sergius near Dubrovnik) to 5,211 m. (Mt. Ararat). In the chapter on the cultivated lands, Mediterranean usage in obtaining water supplies and in irrigation is described. Introduced cultivated plants came principally at five epochs, namely, Alexander's expedition to the east in 331–324 B.C. (although its importance for plant introduction was not actually great); the epoch of Arabian influence, from the eighth to the twelfth centuries; the first rounding of the Cape of Good Hope, 1486, and the flowering of the Portuguese colonial empire in the south of Asia; the discovery of America, 1492, and the expansion of colonization in that continent; and the last hundred and eighty years from about the middle of the eighteenth century. The Arabian or Moorish influence is traceable especially in Spain, which owes to it the sugar cane (*Saccharum officinarum*), the lemon (*Citrus medica* ssp. *limonum*), the bitter orange (*Citrus aurantium* ssp. *amara*), and improved varieties of the carob-tree (*Ceratonia siliqua*). The sweet orange (*Citrus aurantium* ssp. *sinensis*) was brought to the Mediterranean later, in the days of the Portuguese

colonial power, to which also the mulberry (*Morus alba*) from China is due.

In the chapter on the plant geography of the region it is noted that as yet no flora, or even catalogue of plants, exists which embraces the whole of the Mediterranean basin, and there are very great gaps in the information concerning the component countries. Before a complete flora could be compiled, many years and perhaps decades must elapse, but particularly desirable in the meantime are revisions of the flora of Spain, Algeria, Tunisia, Asia Minor, and the Caucasus lands. In view of the present incomplete state of information, Dr. Rikli's work constitutes a valuable addition to any botanical library.

PHYSICS OF ELECTRIC CONTACTS

Electric Contacts

By Dr. Ragnar Holm. Pp. xvi + 398. (Stockholm: Almquist and Wiksell (Hugo Gebers Förlag), 1946.) 45 kr.

THE passage of electricity across the opposed faces of metallic contacts in a current make-and-break circuit involves most of the fundamental mechanisms of electron emission from conductors and semi-conductors and of transport through gases. It is for this reason that a book which gives a comprehensive treatment of the subject is likely to be of interest to the physicist as well as to the electrical engineer and metallurgist concerned with the development of contacts for circuit-breakers, microphones, and current-collectors. The questions involved are not entirely electrical, for, in addition to problems of powder metallurgy, there are also those of friction, wear, and lubrication; in fact, the study of electrical contacts has led to important conclusions in the theory of friction.

Dr. Holm, who was formerly research physicist at the Siemens Works, Berlin, treats his subject in three distinct parts. Part 1, of 186 pages, deals with the elementary processes involved in the passage of electricity across stationary electrode surfaces. It introduces the idea of constriction resistance, in which the lines of current-flow through clean electrodes are constricted through the minute areas at which the actual contact is considered to take place. After describing the effects of tarnishing layers, oxide growth is discussed in the light of the theories of Wagner, of Mott, and of Schottky on metallic ion diffusion through the oxide layer, and experimental data on the growth of such layers are given. The tunnel effect of the transmission of electron waves through a potential barrier, rather than a lattice disturbance, is shown to account for the electrical conductivity across the thinnest superficial films; but if the oxide film is thicker than about 500 A., then its intrinsic conductivity is made responsible for its resistance. An outline of the theory of electron conduction in semi-conductors is given, and the relative contributions of the processes of thermionic and field emission are discussed, and related to the interesting case of cuprous oxide. After touching upon Schottky's theory of dry rectifiers, the non-reversible increase of conductivity obtained with high electric fields is discussed, and attributed to coherer action caused by the generation of minute metal bridges through the film. This accounts for the conductivity of the apparently insulating black films, about 100 A. thick, found on the commutators or rings of electrical machines. Contact adherence and sintering are briefly treated before completing Part 1 with an account of the resistance of pressed powders, and of the action of the microphone.

Part 2, of 53 pages, deals mainly with mechanical aspects of sliding contact, and it discusses hydrodynamic lubrication, graphite sliding, and the theory of friction between solid bodies. Considerable experimental data on wear and on jerky motion are given, and these are considered, with theory, in relation to the practical cases of carbon brushes, copper slip-rings, and railway current-collectors. In fact, it is a pleasing feature of the whole book that, whenever possible, theories are discussed quantitatively in relation to practical applications.

Part 3, of 104 pages, deals with separating contacts, and gives the elementary theory of the short arc, its duration and suppression, and the transport of matter across the gap. Discussion is limited to weak currents, because heavy-current breakers lie outside the scope of the book; but numerous experimental results are given with diagrams and oscillograms illustrating arc extinction and suppression. The author distinguishes two different processes of matter-transfer in the discharge: arc transfer, which includes evaporation, condensation, and sputtering, and bridge transfer, which occurs in the absence of arcing owing to the formation of bridges of molten metal between the electrodes. The treatment of the physics of electrode erosion is, unfortunately, almost entirely empirical, and is based on a large number of measurements of the metal lost after numerous arcing operations with various materials. These show that the matter lost is proportional to the total quantity of electricity passed through the arc. In attempting to explain this result, the assumption is made that the quantity evaporated from the cathode is proportional to the energy liberated there by the positive ions from the discharge. This assumption, however, ignores the loss of energy from the electrode by conduction and radiation, and these processes are not considered because of an empirical result that the loss of metal is only slightly influenced by the cathode temperature. On the other hand, this result is only explicable if these processes are investigated, but the important energy balance at the electrode is nowhere considered. Consequently, no general relation between the erosion-rate and all the physical properties of the electrode is deduced, but in its place a large mass of experimental data is given for suitable electrode materials in different atmospheres. Further, the possible effects of gas-atomic association at the cathode, which might account for the enhanced erosion recorded in hydrogen, are not discussed. Finally, the author attributes all unusual loss or growth of material to its transfer as ions in the arc. Extensive data on bridge transfer are given, and an empirical relation is found between the matter transferred and the current.

The book contains comprehensive author and literature and subject indices, and an interesting historical section. The printing and lay-out are excellent, and the translation is clear. The book, which appears to be an expansion and revision of the author's previous work (Berlin, 1941), admirably fulfils its purpose of describing the physics of contacts, and is likely to be of considerable interest to electrical engineers and experimental physicists alike.

F. LLEWELLYN JONES

Woodcock Ways

By Henry Marion Hall. Pp. xii + 84 + 8 plates. (New York and London: Oxford University Press, 1946.) 30s. net.

The Ruffed Grouse

By Henry Marion Hall. Pp. vii + 91 + 8 plates. (New York and London: Oxford University Press, 1946.) 30s. net.

IN these two books, Mr. Henry Marion Hall, assisted by Mr. Ralph Ray as illustrator, gives us accounts of the ruffed grouse and the woodcock from the point of view of the American sportsman. However, both species are of considerable ornithological interest, and there is much in the volumes to hold the attention of the reader on the other side of the Atlantic, who will admire the dramatic colour pictures and the excellent black-and-white sketches. The author's remarks on game preservation,* in particular his remarks on the protection of the ruffed grouse and on predator control, are most commendable. "The experience of generations of gamekeepers abroad," he says, "has shown that foxes, hawks, owls, weasels, and other animals must be controlled wherever their abundance proves dangerous to feathered game. To exterminate them, however, is worse than useless. A reasonable number should be left alive to eliminate weakly or diseased game birds. This service leads to the survival of alert, vigorous stock and at the same time tends to check the spread of infectious ailments."

After considering the fox in relation to game-birds, Mr. Hall adds: "Cats are a worse menace than foxes—particularly those homeless animals . . . that roam the woods and fields, where they destroy innumerable birds. On some farms as many as a dozen predatory cats have a precarious, nominal home, or at least a headquarters. These animals are even more destructive than foxes."

Such remarks apply equally to the English countryside, and as already hinted the British sportsman reader will find much in Mr. Hall's two books not only to interest him but which he will also endorse.

F. PITT

Meson Theory of Nuclear Forces

By Wolfgang Pauli. Pp. vii+69. (New York and London: Interscience Publishers, Inc., 1946.) 12s.

THIS little book consists of amended lecture notes of a course given by the author at the Massachusetts Institute of Technology in the autumn of 1944. It will be welcome to many who are interested in the problem of nuclear forces without being able to study the extended and difficult literature.

The first of the six chapters contains an account of the interaction of nucleons regarded as point sources of the meson field. The method used is explained for the scalar meson field in detail, and so clearly that the reader will have no difficulty in understanding the more condensed sections on the pseudo-scalar and vector meson field which follow. In Chapter 2 the nucleon is introduced as an extended source; the reason for this step is the singularities which appear in the point source theory when higher approximations are attempted. Here a constant a of the dimension length is introduced which determines the spin inertia, that is, the reaction of the eigenfield of the nucleon to the motion of its spin. This quantity is not experimentally known, but cannot be zero, because this would lead to wrong values for the magnetic moment of the nucleon. These magnetic moments are investigated in Chapter 3 together with the scattering of mesons, treated classically. The following chapter contains the quantum theory of scattering. This section will be welcome to many, as it gives an excellent account of Heitler's theory of radiation damping and Heisenberg's S-matrix, which is intended to be a new formulation of relativistic quantum mechanics. Chapter 5 deals with the neutron-proton scattering, and Chapter 6 with the two-nucleon system in the so-called strong-coupling case (where the 'dimension' constant a of the source is small compared with the Compton wave-length of the meson).

The results of the calculations are compared with the experimental data. The most important of these are enumerated right at the beginning of the first chapter; they are the binding energy of the deuteron, the cross-section for neutron-proton scattering and the quadrupole moment of the deuteron. Rather scanty material indeed, if compared with the complication and refinement of the calculations; and even these few data are not satisfactorily explained by the theory. One gets the impression that one has to do with a preliminary exploration which may lead to nowhere until a quite new and unexpected turn is taken. However this may be, the author deserves our thanks for his short and clear exposition of a difficult subject.

MAX BORN

Science and the Creative Arts

By W. B. Honey. Pp. 84. (London: Faber and Faber, Ltd., 1945.) 6s. net.

IT is impossible not to welcome this sensitive, and in part brilliant, essay with open arms. At the same time, it is equally difficult to accept all of it without reserve. Mr. Honey does well to stress that a work of art is an 'ultra' event, transcending the metrical limitations inherent in scientific methodology. Nevertheless, it is very doubtful whether men of science do, in fact, claim to evaluate art in terms of immediate usefulness. What is more likely is that the difficulty experienced in deciding what is 'pure science' and what is 'applied science' has extended to the frontier region between the 'fine arts' and the 'applied arts' with the equivalent blurring of intention. The author's ideal State, sketched in his last chapter, will need to focus upon this boundary line very critically if it is not to produce aberrations gross enough to obliterate the true image. For the rest, many will be encouraged by such a deeply felt attempt to discover the good and the beautiful, and to render them available to all and sundry; and this in spite of one or two sweeping generalizations which either side (materialist or 'other-worldly') will do well not to take too seriously.

F. IAN G. RAWLINS

English–Spanish Chemical and Medical Dictionary

Comprising terms employed in Medicine, Surgery, Dentistry, Veterinary, Biochemistry, Biology, Pharmacy, Allied Sciences and related Scientific Equipment. By Morris Goldberg. Pp. ix + 692. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 50s.

THIS is a dictionary intended to assist technical translators in the preparation of literature in Spanish. Apart from the Spanish equivalent of each English word there follows, wherever necessary, a brief simple explanation of the term in Spanish. The scheme is excellent and well executed, and the book should be of great value to commercial undertakings dealing with Spain and Spanish America.

RELATIONS BETWEEN SEA WAVES AND MICROSEISMS

By Dr. G. E. R. DEACON, F.R.S.
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ONE of the possibilities suggested by Admiralty research on waves and swell during the past two years is that of obtaining information about the wind and waves in a distant storm area by examining the first swell that reaches the coast[1,2].

By comparing wave recordings and the winds over the ocean, it has been demonstrated that all wave-periods are generated in a storm, up to a maximum which depends on the greatest wind strength. The longest waves are the first to arrive on a distant coast, since although they are not generated until the wind reaches its greatest intensity, they travel faster than the shorter waves generated in the early part of the storm. They arrive at the distant coast as very low swell, which is usually not visible because it is obscured by shorter waves generated in the coastal region or in another storm. To make sure of detecting it, routine wave recordings must be submitted to frequency analysis in sufficient detail to allow the amplitude of each wave-length to be measured.

The first indication which the wave spectra show of a distant storm is usually a narrow band of activity of periods between 18 and 24 sec., and the appearance of such a band generally implies that heavy swell will follow. The indication is not altogether reliable, because the long periods may come from a very distant storm, too far away to produce heavy swell at the recording station. A precise indication of the distance of the storm can be obtained from the subsequent spectra.

By choosing examples of storms of limited extent and duration for which there are adequate meteorological observations, a fairly accurate estimate can be made of the time at which successive wave-periods begin and cease to be generated; and by comparing these estimates with the times at which the same periods begin and cease to arrive at the distant recording station, it has been shown that the different periods travel independently across the ocean at speeds which correspond very closely to their theoretical group-velocities. This result makes it possible to use the measured times of arrival of the different wave-periods to calculate the distance of the storm from the recording station.

The wind strength in the storm can be estimated from the maximum wave-period, using an empirical relation which has been found to hold reasonably well for North Atlantic storms. For winds stronger than 30 knots, it has been found that the speed of the gradient wind in the strongest part of the storm has the same numerical value as three times the maximum wave-period. It is interesting to note that since the wave-velocity—as distinct from the group-velocity—in deep water is approximately three times the wave-period, the fastest waves travel at about the same speed as the gradient wind, which is possibly a measure of the strongest gusts at the surface.

There is some difficulty in following the track of a storm over a long distance unless its intensity varies sufficiently from time to time to give rise to a succession of recognizable wave-bands, so that the extended storm can be treated as a succession of small storms; but there is much in the new techniques that can be used to obtain information about approaching swell and distant storms, and further progress is being made.

The information is of practical value in countries the weather and harbours of which are influenced by storms passing over oceans in which few meteorological observations are made. In many respects the usefulness of the information is limited, because it comes too late owing to the long time which elapses between the generation of the waves and their first arrival on the coast. This time lag would be avoided if microseisms could be used instead of waves, the travel time of the microseisms being negligible in comparison with that of the waves.

The idea is not a new one. Linke[3] sought to use microseisms for weather forecasting, and Bernard[4] found that they might be useful for forecasting waves on the coast of French Morocco. He showed that a day-to-day graph of the swell on the coast of French Morocco had the same shape as a day-to-day graph of the amplitude of the microseisms at Strasbourg, except that the peaks of microseismic activity preceded the peaks of wave activity by one to three days according to the distance of the wave-generating area from the coast. He concluded that the waves and microseisms are generated simultaneously in the storm area, and that the microseisms precede the waves because of their greater velocity (approximately 2½ miles/sec.). This suggests a useful method of predicting swell, but an examination of the literature reveals many uncertainties.

The term microseism should probably include all movements registered by a seismograph that are too small to be regarded as earthquakes; but there seems to be a general consent to use the name for the more or less sinusoidal oscillations, with periods up to 10 sec., that cannot be attributed to local factors such as traffic, or varying wind pressure on tall objects near the observatory. It was soon recognized that they were in some way associated with wave activity on neighbouring seas and oceans, and three outstanding hypotheses which have been put forward to explain them are listed below. A fourth which may supersede them will be mentioned later.

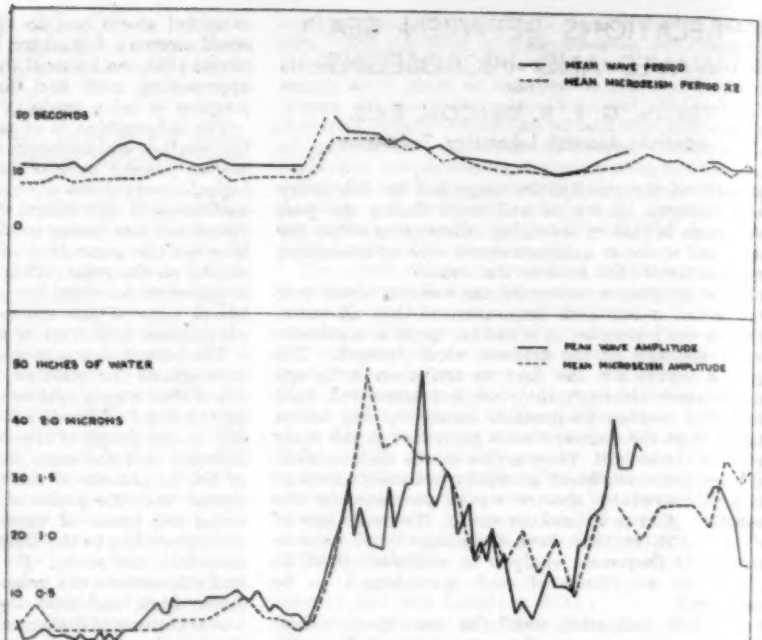
(*a*) Waves in a coastal region. Wiechert maintained that microseisms could be explained by the impact of waves against a steep rocky coast, and this view was supported by Gutenberg and others. Leet[5], at Harvard, concluded that although surf was probably the dominant factor, insistence on steep rocky coasts was inadequate to explain the activity from certain directions.

(*b*) Waves in the open ocean. To explain why the largest microseisms produced by a storm in the Bay of Bengal were recorded several hours before the storm reached the coast, Banerji suggested that pressure waves are transmitted to the sea bottom, which is set in vibration and the motion propagated along the sea bed.

(*c*) Atmospheric oscillations. Gherzi found that large microseisms were recorded on the China coast when there were cyclones over the sea, but not when the waves were due to monsoon winds. He suggested that the microseisms may be caused by atmospheric oscillations or 'pumping' near the centre of a cyclone. The possibility that they may be formed by atmospheric oscillations over the land has also been mentioned.

Most of the conclusions that have been reached are of a tentative nature. If two or more sources of microseisms are operating together, especially in the presence of qualifying geological and topographical features, special methods will be needed to discriminate between them. One hypothesis or another can be held to explain a series of measurements, but in the absence of sufficiently comprehensive observations it is usually not difficult to suggest an alternative.

In the past few years, more detailed observations have been made by J. J. Shaw, Tromsdorff and others, largely with the object of obtaining detailed information about the direction from which the microseisms are travelling. Ramirez[6], at St. Louis, used instruments at the vertices of a right-angled triangle the shorter sides of which were about 6 km. long. He found that individual microseismic waves could be detected at each of these stations, and calculated the direction of propagation from the small differences between the times of arrival at the three corners of the triangle. Simultaneous observations at Florissant, 22 km. distant, were also used.



COMPARISON OF THE AMPLITUDES AND PERIODS OF THE PRESSURE VARIATIONS BELOW WAVES AT PERRANPORTH WITH THE AMPLITUDES AND PERIODS OF MICROSEISMS RECORDED AT KEW

The first result was a confirmation of the general belief that the source of microseisms is not to be found over the land but over the ocean. The direction from which the microseisms travelled was calculated for all large microseismic storms, and in that direction there was always a deep barometric depression over the water. No correlation could be obtained with microbarometric variations or pressure distribution over the land. No special attempt seems to have been made to correlate the microseisms with surf on the Atlantic coast, but it is concluded that although the beating of the sea waves against rocky coasts may explain some of the microseisms, it will not explain those of a barometric depression far out over the sea. These are said to reach their peak and subside long before the storm waves reach the coast.

The results obtained by Ramirez were the chief factor in persuading the meteorological branch of the U.S. Navy to initiate a comprehensive research project to determine whether microseismic recordings could be used for tracking hurricanes. The first recording station was set up in Cuba in 1944, and two others, in Porto Rico and Florida, came into use in 1945. Each station had three seismometers at the vertices of an equilateral triangle the sides of which were 8,000 ft., and in the two later stations each instrument, suitably mounted in a vault, was connected to a central recording apparatus by cable and the three traces recorded side by side on the same drum. The movements and variations in intensity of storms over the neighbouring ocean were known with some certainty from observations made on regular meteorological flights.

The results of the first two years work are described by Gilmore[7], who concludes that the dominant microseisms recorded during a storm are in some way caused by a deep barometric depression or strong wind over the ocean, and transmitted directly from the storm centre. He says that the data rule out even a possible chance that they could be associated with surf. He admits that his results do not disprove that microseisms are generated by surf, but he is satisfied that the dominant 2–7-sec. oscillations are not produced by it. Most of the conclusions are drawn from records taken at the station in Cuba, but afterwards cross-bearings were obtained from the three stations. So far as this region is concerned, the technique seems to afford a satisfactory method of tracking storms.

On the European side of the ocean the task appears more difficult. The work of Wiechert and Gutenberg is sufficient to establish the importance of the effect of waves in the coastal region. More evidence has been obtained by comparing wave measurements at the Admiralty station at Perranporth with the vertical microseismic component at Kew. Only two months records have been examined, but they are sufficient to show that the microseismic activity at Kew is related to the wave-height on the Atlantic coast of Britain.

One example of such a comparison, using the wave pressures recorded by an instrument laid in 70 ft. of

water at Perranporth, is shown in the accompanying graphs. Further evidence is given in a second paper by Bernard[8], in which the wave characteristics on the coast of Morocco are compared with the microseismic activity at Averroës on the same coast, as well as with the recordings at St. Maur, near Paris. The microseisms in Morocco reach their peak activity at the same time as the waves on the coast, and Bernard is convinced that they are produced as the waves approach the coast. He still attributes the peak values at St. Maur, which are reached one to three days before those in Morocco, to microseisms transmitted directly from the storm centre; but with our present knowledge of the propagation of waves and the experience gained by comparing the waves at Perranporth with the microseisms at Kew, it seems more reasonable to attribute them to wave activity on the coasts of France and the British Isles. Swell moving eastwards from most depressions in the North Atlantic Ocean reaches these coasts one to three days before swell from the same depression moving south-east reaches the coast of Morocco. The evidence available so far suggests that microseisms transmitted directly from the storm centre will have to be detected in the presence of oscillations of greater amplitude produced by waves in the coastal region.

The existing explanations of how a deep barometric depression over the ocean, or the entry of waves into a coastal region, produce microseisms are not satisfactory. The most obvious difficulty in explaining the origin of microseisms in deep water was that the amplitude of sea waves decreases exponentially with depth, so that there is no movement in deep water. Whipple and Lee[9] showed that in a compressible medium there would also be shock waves; and other authors, taking the elasticity of the sea bottom into account, have sought to explain microseisms as a result of such shock waves. A serious objection to this explanation, and to the view that microseisms could be produced by the impact of waves against a steep rocky coast, is that since the waves are short compared with the wave-length of the microseisms, the pressure variations due to them would tend to cancel out, so that the total effect is likely to be small. Bernard[8] answers this objection by assuming that the microseisms are produced in places where the interference between wave trains gives rise to standing oscillations. He maintains that such oscillations can be expected in the centre of a cyclone and quotes a reference by Charcot to the pyramidal waves found in the storm centre; he also postulates their existence in a coastal region where the coast or a submarine bank is sufficiently steep to cause reflexion.

A new consideration is introduced by the discovery that the microseism periods are approximately half the wave-periods. Bernard was the first to emphasize this relation, made apparent by his comparison between the microseism and wave-periods in Morocco, and it was later discovered independently as a result of the comparison of the waves at Perranporth and the microseisms at Kew. These are both examples of the effect of waves in a coastal region; but the same relation appears to hold for microseisms generated in a storm area, since those recorded by Ramirez and Gilmore are half the most probable wave-periods. The theory of the generation of microseisms must therefore explain a frequency doubling.

Longuet-Higgins and Ursell, in work which it is hoped will be published shortly, have pointed out that Miche[10] in a theoretical paper on waves has shown that the average pressure on the sea bottom below a standing wave varies sinusoidally with twice the frequency of the wave, and with an amplitude which does not decrease to zero with increasing depth. Expressing the problem more precisely than Bernard, they have extended the work of Miche to more general wave systems. In particular, they have shown that when wave patterns containing predominant groups of swell of the same period cross in opposite directions, the mean pressure on the sea bottom over the whole area varies with twice the frequency of each wave train, the amplitude of the variations being proportional to the product of the amplitudes of the separate wave trains. Such wave patterns can be expected near the centre of a cyclonic disturbance owing to interference between the waves generated in opposite quadrants, and near a coast owing to reflexion from the shore. A quantitative comparison of the expected and observed results has been made for Perranporth and Kew with satisfactory results. To make a similar estimate for a storm centre in deep water requires further knowledge of the sea conditions.

This new theory of the generation of microseisms possesses some very attractive features. It can explain why microseisms may be produced in a cyclonic disturbance, but not by a monsoon wind, and near a rocky coast, without excluding coasts that are less steep; the necessary wave interference may not be found in every depression, nor in waves approaching the coast from every direction. In particular, it shows how pressure variations of the right period can be produced over relatively large areas of the sea bottom.

As proved with ocean waves, a better understanding of microseisms will be obtained when account is taken of possible interference between microseismic waves from different sources. Although Gilmore describes striking successes in tracking a cyclone by microseismic direction-finding, the more general problem, for countries farther removed from the cyclone track, will involve the discrimination between microseisms generated in a storm area and those generated near the coast. The techniques developed for wave analysis are likely to prove useful; and to obtain sufficiently precise and comprehensive data to allow a detailed study of microseismic generation, microseisms and waves must be studied together. The results are likely to be of practical value, and the subject has many aspects of interest to oceanographers and geophysicists.

The assistance of the director of the Meteorological Office and the superintendent of Kew Observatory is gratefully acknowledged; also that of M. S. Longuet-Higgins and F. Ursell of the Oceanographical Research Group at the Admiralty Research Laboratory, and Mr. R. T. Ackroyd, who began this study before accepting a research fellowship at the University of Liverpool. I am indebted to the Admiralty for permission to publish this article.

[1] Deacon, G. E. R., Occasional Publications of The Challenger Society, No. 1 (1946).
[2] Barber, N. F., and Ursell, F., *Nature*, **159**, 205 (1947).
[3] Linke, F., *Erqeb. königl. Geo. wiss. Göttingen, Math. Phys. Klasse*, 7 (1909).
[4] Bernard, P., *C.R.*, **205**, 163 (1937).
[5] Lee, L. D., *Beitr. z. Geophys.*, **42**, 232 (1934).
[6] Ramirez, J. R., *Bull. Seismol. Soc. America*, **30**, 35 and 139 (1940).
[7] Gilmore, M. H., *Bull. Seismol. Soc. America*, **36**, 88 (1946).
[8] Bernard, P., *Bull. Inst. Oceanographique, Monaco*, **35**, No. 800 (1941).
[9] Whipple, F. J. W., and Lee, A. W., *Roy. Ast. Soc., Geophys. Supp.*, **3**, 287 (1935).
[10] Miche, M., *Ann. des Ponts et Chaussées*, **114**, 25 (1944).

TERCENTENARY OF DENIS PAPIN

By Dr. H. W. DICKINSON

THE tercentenary of the birth of one of France's famous sons, the natural philosopher, Denis Papin, occurs this year and is being marked by commemorative meetings there; and there is every reason for taking cognizance of the event in Britain, for it was here that he carried out much of his scientific work.

The time in which Papin was born was propitious, for it was marked by the quickening of the world of ideas after the comparative stagnation of the Middle Ages and by the rise of a new system of philosophy resting on a basis of experiment and observation, of which Francis Bacon, Viscount St. Albans, was the earliest and most distinguished exponent in Britain. This new attitude to knowledge led to the foundation of scientific societies in many cities of Europe, of which we need only mention the Royal Society, London, 1662, and the Académie Royale des Sciences, Paris, 1666.

Renewed interest in Papin and his work has been aroused by the formation of a Comité Denis Papin to commemorate the tercentenary, and this has led, in one direction, to inquiry as to his birth, hitherto believed to have taken place at Blois in the Duchy of Orléans (now Département Loir-et-Cher). Recently, by the researches of M. J. Chavigny of Blois, it has been shown that Papin was born at the farmhouse of the Papin family at Coudraies, 1½ miles from Chitenay, which itself is twelve miles from Blois. It was at Blois that Papin was christened on August 22, 1647; this has led to the statement, hitherto quite naturally accepted, about his birth. It was as an outcome of this discovery that the Denis Papin Committee, with the co-operation of the Maire and Commune of Chitenay, organised a celebration in the village on July 20, in the course of which a tablet on the farmhouse was unveiled by Prof. A. Portevin, representing the French Academy, in the presence of delegates from foreign countries and an assembly of the local inhabitants. The inscription on the tablet is as follows:

Closerie des Papins
Dans cette maison serait né
Denis Papin en Août 1647.

Offert par le Comité Denis Papin
20 juillet 1947

The uncommon word 'closerie' has no exact equivalent in English—it connoted originally a peasant holding of land worked on the *metayer* system; perhaps we may translate it 'farmsteading'.

Papin early displayed ability, and by the help and encouragement possibly of his uncle and grandfather, who were physicians, he was enabled to proceed to the University of Angers, at the capital of Anjou, to study there, and in 1669 he took the degree of M.D. He practised in the city for some years as a physician, but like so many provincials he was attracted to Paris. There he became assistant to the celebrated Christiaan Huygens, who had been invited to Paris in 1666 by the great finance minister, Colbert, to establish the Académie des Sciences on a secure foundation.

In Paris, Papin was employed on experimental physics, notably on the air pump. This research enabled him in 1674 to publish his "Nouvelles Expériences du Vuide". Alarmed probably by the growing danger that threatened those of the Protestant faith—for Papin was a Huguenot—he emigrated to England in 1675, anticipating by ten years the revocation of the Edict of Nantes. He found employment as assistant to the Hon. Robert Boyle. At that time the latter was busy on improvements in the air pump, and Papin's experience was just what was wanted. Incidentally, he helped at the meetings of the Royal Society. One of the most notable of those he met in this way was Robert Hooke, curator of experiments to the Society since 1662. The duty of the curator was to produce and demonstrate experiments in physics, chemistry and mechanics at the weekly meetings. This tended, of course, for his energies to be dissipated over too wide a field, and it was probably a relief to him when Papin in 1679 was appointed his successor, but at the reduced salary of £20 a year. It involved a busy time, and the collaboration with the pregnant mind of Hooke could not have been otherwise than stimulating. While thus engaged, in 1681 Papin invented his "New Digester or Engine for Softening Bones", in which animal products are stewed by heat under pressure; this was a great advance in technique fraught with many valuable applications in subsequent years. To limit the pressure in the digester and so avoid bursting it, Papin employed the lever safety valve, with the invention of which he is not quite correctly credited; what is certain is that he was the first to illustrate it in print, and this was in the thesis that he wrote in 1681 with the above title; a version in French, "La manière d'amollir les os", also appeared in the following year. John Evelyn, in his "Diary" under date April 5, 1682, tells with gusto and appreciation of a supper cooked with the digester and partaken of in company with other fellows of the Royal Society after a meeting. He remarks: "This philosophical supper caus'd much mirth amongst us and exceedingly pleas'd all the company", as one can well imagine.

In 1680 Papin was elected a fellow of the Royal Society, but strangely enough his signature does not appear on the roll of fellows, possibly because just prior to the election, as Evelyn states: "he has since gone to Venice with the late President here [Sarotti] . . . who carried this excellent mechanic, philosopher and physician to set up a philosophical meeting in that city". He did actually take this journey and accept the employment in 1681; but the institution thus set up lasted a few years only and he was back again in London in 1684, where he was re-appointed curator of experiments to the Royal Society. However, in 1685 he was appointed by the Landgrave Carl of Hessen Nassau professor of mathematics in the University of Marburg. It was here in 1690 that he published an account of experiments with an apparatus that has been acclaimed as the genesis of the steam engine. A film of water, contained in the bottom of a cylinder fitted with a piston, was placed over a fire, when the water was turned into steam and lifted the piston, which was then latched in the raised position. The apparatus was then moved from the fire and allowed to cool. On unlatching the piston, it was pushed down by the atmospheric pressure above it and raised a weight by a cord over a pulley. He does not say how long the experiment took. Obviously this was nothing more than a lecture-table experiment, and went no distance in the direction of making a working engine of it. As time went on, Papin gradually changed his conceptions and inclined towards using steam under considerable pressure, for

in 1698, replying to a query by the celebrated philosopher G. W. F. Leibniz at Hanover, with whom Papin had been since 1692 in close correspondence, he says: "The manner in which at present I employ fire for raising water is always on the principle of the rarefaction of water. Only I do so at present in a manner much more easy of execution than that which I have published; furthermore as well as using suction, I employ also the pressure that water exerts on other bodies in expanding (by heat) the effects of which are not limited like those of suction. Thus I am persuaded that this invention if it can be pushed as it should be could prove of very considerable utility, but I have not yet made great progress."

The outcome of this was that, in 1707, Papin set down his conclusions in a work published at Cassel entitled "Nouvelle Manière pour lever l'eau par la force de feu". In this he advocated an apparatus similar to, though perhaps not so efficient as, the 'fire engine' patented and introduced in 1698 by that prolific inventor Thomas Savery, in which steam at high pressure was used to raise water much in the way that is done by the pulsometer of to-day. Evidence that Papin's engine was made and used is lacking, but had it been so there is no reason to believe that it would have been any more successful than that of Savery; the latter, unlike Papin, was a practical man, with a workshop in Salisbury Court, Fleet Street, London, and if anyone could have made the fire engine a success he could. The fact was that both the philosophers and the practical men of the day were thinking along the wrong lines, for in the then state of the mechanic arts steam boilers could not be made to stand the high pressure that they required. It was reserved for Thomas Newcomen, an ironmonger of Dartmouth, Devon, who, recognizing the limitations of craftsmanship and of the materials at his hand, employed steam of no higher pressure than that of the atmosphere under a piston in a cylinder and condensed the steam with a jet of water, thereby succeeding by 1712 in inventing a practical engine. Papin can be awarded the credit that he was the first to suggest that by creating a vacuum under a piston in a cylinder the pressure of the atmosphere could be made to do work.

The truth is that Papin was a most fertile inventor —his brain teemed with ideas—but time and opportunity did not allow, or was not allowed, to serve to reduce them to practical working machines. We may instance the Hessian pump, which was the undoubted forerunner of the centrifugal pump of a century and a half later. Papin took up many other schemes that it would be tedious to enumerate, and we shall only mention his mechanically propelled boat, by which, having decided in 1707 to return to England, he had the crazy idea for a man in his sixtieth year of paddling down the River Weser to Bremen. Starting from Cassel along the River Fulda, he got as far as Münden, the junction with the Weser, when he was stopped not only by the customs authorities but also by the bargemen, who feared that their livelihood was threatened by the new-fangled craft. The statement that he employed his steam engine to propel the boat is more than doubtful. Undeterred, he continued his journey overland, and on arrival in England, he seems to have received a cool reception. Several of his good friends had died while he had been away: Boyle in 1691; Sir Joseph Williamson, who had been president (1677–80) of the Royal Society; and Hooke in 1703; Richard Waller, appointed in 1682 to succeed Hooke, was now secretary to the Society.

On February 11, 1708, Papin submitted to the Royal Society a proposition to "construct a boat to be rowed by oars moved with heat", following on the lines of the one he had built at Cassel; but the Society would not advance the requisite sum, estimated at £15, for the experiment, and so the project fell through. How he lived during the next four years we can only surmise. In 1711 alone he submitted six papers to the Royal Society. In the last letter extant from him, addressed to Sir Hans Sloane and dated January 23, 1712, he concludes pathetically but bravely, "Certainly, Sir, I am in a sad case since even by doing good I draw ennemi's upon me, yet for all that I fear nothing because I rely on God Allmighty". We hear nothing further about him, and the supposition is that he died a few months later in Soho, where he had been living. All efforts to find out particulars of his death have been unsuccessful. Thus passed away an acute natural philosopher, a clever mechanician and a fertile inventor, who sowed the seeds of several inventions that were to bear fruit in after years.

Further steps to commemorate the tercentenary are being taken. An exhibition of documents, models and drawings concerning him and his work was held at Blois during August; to this the Royal Society contributed microfilms of all Papin documents still in its possession. His baptism was commemorated on August 22 in the church at Blois; and a ceremony will take place at Angers to recall the conferring of his doctorate of medicine. In October an exhibition will be held at the Conservatoire des Arts et Métiers, Paris, including much of the material shown at Blois; finally, a commemorative meeting at the Sorbonne is being arranged.

PLANT BREEDERS' CONFERENCE AT CAMBRIDGE

A COMPREHENSIVE picture of all the phases of plant breeding work at Cambridge was seen by plant breeders assembled for the first conference called by the Agricultural Research Council and held during July 9–11, for workers from the Aberystwyth, Cambridge and Corstorphine Plant Breeding Stations and the John Innes Horticultural Institution, Merton. Such conferences were recommended by the Plant Breeding Survey Group of the Agricultural Research Council and in future years will meet at the other stations in turn, enabling workers at breeding stations supported by the Council in Great Britain to learn the main outlines of the work at the other institutions and to discuss their common problems.

The conference was rather informal; talks and laboratory and field demonstrations were used to describe to the visitors the work of the Cambridge University Plant Breeding Institute, and visits were also paid to the Imperial Agricultural Bureaux Empire Potato Collection, the Horticultural Research Station and the National Institute of Agricultural Botany.

The Plant Breeding Institute, one of the research institutes of the School of Agriculture, is engaged in the improvement of wheat, barley, oats, potatoes, sugar beet and forage crops. The staff of the Institute at present consists of Dr. G. D. H. Bell (acting director), Sir Frank Engledow, Mr. C.

Barclay, Dr. A. B. Bauer, Mr. A. Bolton, Mr. J. L. Fyfe and Dr. H. W. Howard. Much of its work follows the well-established methods of breeding, being based on inter-varietal crosses, with pedigree selection leading to small-scale trials. An example of a breeding programme of this kind was seen in wheat—the continuing work of combining the good milling and baking qualities derived ultimately from Red Fife with the characteristics required in an English wheat variety. This work has already led to the production of Yeoman and Holdfast, the latter a typical successful modern wheat with high yield and short straw suitable for fertile soil and for 'combine' harvesting. It is a white-grained wheat with something of the tendency to sprouting in a wet harvest which is so often found in white wheats. From crosses with red-grained varieties, selections have been obtained with red grain (and therefore less sprouting), and some of these have reached the stage of N.I.A.B. trials. Similar methods are being used in the improvement of wheat varieties for biscuit-making and of spring wheat varieties.

With malting barleys, three main lines of improvement are being followed:

(1) The general improvement of Spratt–Archer and Plumage–Archer, the two main spring varieties for Britain. This has led to the production of Earl, a selection from Spratt–Archer with the characteristics of that variety coupled with 7–10 days earlier maturity.

(2) The breeding of varieties more resistant to lodging by crossing with the short-strawed Danish varieties Kenia and Maja.

(3) The development of winter-hardy malting varieties of which Pioneer, a two-rowed winter form, and Prefect, a six-rowed form, are already on the market.

Attention is also being given to the breeding of feeding barleys, especially for soils the fertility of which precludes the growing of first-class malting barley. Camton is an example of a variety with high yield and good standing powers produced with this requirement in view, though it has since proved to be a reasonably good malting barley.

In oats the most important line of work is the development of winter oats of good grain quality (low husk percentage) and good standing power. A great handicap in this work is the lack of a highly winter-hardy parent, the British variety Grey Winter and the similar French variety Avoine Grise d'Hiver being the main sources of winter-hardiness. From crosses between Grey Winter and a stiff-strawed spring oat of unknown origin called Argentine, the varieties Resistance and Picton were bred. Picton practically equals Grey Winter in hardiness and has white grain and much better standing power. Resistance also has much better standing straw but is not sufficiently winter-hardy; by crossing it again with Grey Winter, a hardier type, *C.A.*10/3, has been developed and is now in trial at the N.I.A.B.'s substations. The breeding of spring oats suitable for the drier conditions of the Eastern Counties is also in progress, and here again one selection has reached the stage of N.I.A.B. trials. Special attention is also paid to the development of spring varieties resistant to frit-fly.

The close relation between seed production and plant breeding is well illustrated by the work on sugar beet breeding. This was started during the War when Britain was cut off from Continental sources of seed, as a precaution to help safeguard the home-grown seed supply. From this beginning has developed a breeding programme a feature of which is the attention paid to ancillary criteria of selection such as cluster characteristics, seedling establishment, biochemical features and the physiology of development; low temperature and continuous light treatment are used to intensify any tendency to annual habit, and so lines susceptible to bolting can be detected even in a season when bolting is not prevalent.

Field peas, beans, sainfoin and lucerne are the principal forage crops worked on at the Plant Breeding Institute. The work on peas shows how the plant breeder can assist the farmer by making harvesting easier. New varieties have been produced, some with shorter haulms, others with earlier maturity, and yet others with several pods per node and therefore more nearly simultaneous ripening. Selection for resistance to black fly is the main objective in the work on spring beans. With sainfoin and lucerne, improvement by selection of parents which have been progeny-tested by inbreeding and by natural out-pollination is the basic procedure, and it is intended to include crude protein content as one of the criteria of selection. Other crops on which some work has been carried out include maize, sunflower, soya beans, red fescue, cocksfoot and other grasses.

The visit to the Horticultural Research Station provided further examples of plant improvement by the exploitation of diversity within a species, the crops concerned being cauliflowers, broccoli, brussels sprouts, carrots, peas and strawberries.

The later stages of this type of crop improvement were seen at the National Institute of Agricultural Botany, where the visitors were shown observation plots, large- and small-scale variety trials and propagation plots of standard and new varieties of agricultural and horticultural crops.

The breeding of blight-immune potatoes at the Plant Breeding Institute is a good example of the wider possibilities opened up—and the attendant difficulties—when related species are brought into the breeding programme. The foliage immunity to late blight which is being incorporated in the domestic potato (*Solanum tuberosum*, $2n = 48$) is derived from *S. demissum* ($2n = 72$), where it was discovered by R. N. Salaman. He began the work of hybridization, which was transferred to the Plant Breeding Institute on his retirement. Repeated back-crossing by the few domestic potatoes which are pollen-fertile, with continual selection for blight immunity in artificial tests, coupled with selection for the desirable attributes of a commercial potato, have brought the work in some twenty-five years to the stage where the release of a variety is within sight. Forms are now available which are worthy of trial against the standard varieties, and are resistant to the three strains of *Phytophthora infestans* known to exist in Great Britain. At the Empire Potato Collection, housed nearby, wild and cultivated South and Central American potato species and varieties are being systematically studied and maintained for distribution to Empire potato breeders.

Wheat is another crop in which these wider possibilities are being explored at Cambridge. A world collection of wheat species and varieties was maintained and studied there for many years before the War, and it is now being resuscitated. At the same time the widest survey is being undertaken of the possibilities of hybridization within the Triticinæ and the production of synthetic allopoly-

ploids by colchicine doubling. On the more practical side the cross between *Triticum vulgare* and *T. turgidum*, followed by back-crosses to each parent, has been investigated and has led to the breeding of *vulgare*-like forms with the high floret fertility of *turgidum* and of *turgidum*-like forms with shorter straw and earlier maturity.

Phylogenetic and taxonomic investigations in relation to plant breeding formed one of the topics of a discussion held during the conference. J. G. Hawkes reviewed the taxonomy of the relatives of the potato. He showed how studies of the kind pursued at Cambridge and elsewhere, on the classification, geographical and ecological distribution, economically useful characteristics, chromosome number and range of possible hybridization, form a necessary background for the plant breeder's work. J. M. Munro reviewed the work on wide crosses among the Triticineæ. He outlined the relationships of certain species and genera in terms of genom-analysis and described briefly the two main methods of using colchicine to synthesize allopolyploids; the F_1 hybrid may be treated or the parents treated and the resulting forms with double chromosome number crossed to produce a fertile F_1. From the plant-breeding point of view most interest lies in the work of re-synthesizing hexaploid wheats by crossing tetraploid wheats with *Ægilops squarrosa*, *caudata* and *speltoides*. Special attention is being paid to this aspect of the work at Cambridge, the ultimate aim being to introduce the synthesized hexaploids into the wheat-breeding programme.

T. J. Jenkin gave a brief account of the relationships within and between *Festuca* and *Lolium*. The general discussion brought out clearly the inter-relationship between cytogenetic and taxonomic work and the value of both to the breeder in providing him with a guide to the material at his disposal. There was some discussion on the naming of new allopolyploids in relation to the binomial system; it was generally agreed that it was desirable to use purely conventional names to indicate their origin and not to name them formally as new genera or species, at least unless and until they become established as more than purely experimental material.

This topic led naturally to the other subject selected for discussion—living collection of crop plants and their relatives. C. D. Darlington pointed out that we have inherited the needs which prompted the establishment of botanic gardens some 300 years ago, but that the existing botanic gardens no longer fulfil those needs. The provision of one garden to maintain a collection of the economic plants of temperate regions and their wild relatives and ancestors would greatly stimulate the improvement of crops. The staff should include cytologists and geneticists. P. S. Hudson recounted the more or less urgent resolutions which have been unanimously carried at a number of official and scientific conferences where this subject has been discussed. But the position, in fact, remains as it was: a few specialized collections exist in the British Empire, with no organised attempt to co-ordinate them, to extend them or to build up new ones. A lively debate followed in which the relative merits of special and general collections were discussed and the difficulty of maintaining collections at existing stations, unless special financial provision could be made, was stressed. A resolution was passed unanimously urging upon the Agricultural Research Council the present need for the appointment of a collector whose main duty would be the assembly of collections of the type indicated.

The conference clearly fulfilled a long-felt need, and those attending expressed a desire to hold future conferences annually at the four stations in rotation and during the growing season. Even though many of the crops were disappointing owing to the severe and prolonged winter, late sowing and spring drought, the value of having the living material there for discussion was obvious.

OBITUARY

Sir Clive Forster-Cooper, F.R.S.

Sir Clive Forster-Cooper, director of the British Museum (Natural History), died on August 23. He was born in London in 1880, and was educated at Rugby and Trinity College, Cambridge. At Cambridge he became greatly interested in zoology, and in 1900 joined Stanley Gardiner's expedition to the Maldives and Laccadives. Shortly after his return, he joined the staff of the North Sea Fisheries Commission research establishment, spending a year in this service, largely at sea in a converted trawler. He then returned to Cambridge to take part in another expedition designed to enlarge our knowledge of the marine biology of the Seychelles.

Forster-Cooper might thus have devoted his life to the study of marine biology and of fisheries problems, but a meeting with Dr. C. W. Andrews of the British Museum, who had himself worked on marine biology at Christmas Island, introduced him to fossil mammals, and especially to the wonderful fauna of the Fayum. The problems presented by these materials, and the wide importance of fossil mammals in general, seized Forster-Cooper's imagination, and he joined Andrews in an expedition to the Fayum in 1907, learning in this way not only the technique of collecting fossil bones, but also the manner in which an expedition into a desert country could be conducted.

On his return from Egypt, Forster-Cooper felt it necessary to see something of the immense collections of fossil mammals in the American museums, collections incomparably more complete and satisfactory than any in Europe. He therefore spent a year in the American Museum of Natural History, working under H. F. Osborn, who for the rest of his life remained an intimate friend. In New York also he was associated with W. D. Matthew, W. K. Gregory, Barnum Brown and Walter Granger, the group of very able palæontologists who, with Osborn, did very much to establish our knowledge of the history of mammals on a firm foundation; and by taking part in one of their expeditions to Wyoming, he added to his knowledge of collecting technique and to that of preparation.

On his return to Cambridge once more, Forster-Cooper was given the Balfour Studentship and made two arduous, dangerous and most successful expeditions to Baluchistan in 1910 and 1911, there collecting and afterwards preparing and describing the extraordinary rhinoceros *Baluchitherium*, the largest of all land mammals.

By this time Forster-Cooper had become an expert on all the processes of preparation of fossils, in plaster casting and other museum arts, and he had seen many great museums which were using new

methods of display intended to make their work more intelligible to the general public. Thus his appointment in 1914 as director of the Cambridge University Museum of Zoology was a natural one.

His appointment was immediately followed by the outbreak of war, and he spent the period until 1918 in work on malaria. On his return to Cambridge he completely reorganised the Zoology Museum, making it a well-designed teaching collection. At the same time he took some private pupils, who have since become distinguished zoologists, and gave many lectures, becoming University reader in vertebrates. But his activities in Cambridge soon widened out: he became a fellow and bursar of Trinity Hall, and when the accommodation of books and readers in the University library became an embarrassment to everyone, suggested that the only real solution was the radical one of moving the whole to a new and unencumbered site where it could be housed in a modern building designed for that purpose. Ultimately this plan was adopted, and Forster-Cooper, as chairman of the Buildings Syndicate, became responsible for its execution.

But his real interests remained in museum work, and in 1938 he was appointed director of the British Museum (Natural History). There he began to consider and design a new plan for the exhibition galleries which would have made them far more valuable both to students and to the general public. But the advent of the War ended all possibility of putting these plans into effect. The whole staff of the Museum was devoted to packing up the vast collections and placing them in safety. For a long time Forster-Cooper actually lived in the Museum, which suffered much damage from bombs in 1940 and again in 1945. Thus the opportunity of which he would have made such good use came to him too late, and was immediately taken away.

Forster-Cooper had all the qualities of a great museum man. He was a good teacher, with many ideas about the exposition of facts and ideas in a museum. He had a very wide experience of the world, and of zoology. He had seen and considered critically very many great museums.

Most important of all was that he was a man of wide general culture, with a highly developed appreciation of pictures, prints and drawings. Indeed, he was himself an excellent draughtsman, who had painted good water-colours and etched some pleasant plates; and he could, with his own hands, carry out most museum operations.

He was a man of great personal charm, very modest and shy, unwilling to impose his own ideas on anyone.

D. M. S. WATSON

NEWS and VIEWS

Atomic Energy Control

A DISCUSSION of the present situation concerning the international control of atomic energy has recently been issued by the executive committee of the Association of Scientific Workers. The committee believes that on most of the issues concerned there is little difference between the points of view of the United States and the U.S.S.R., that "a start should be made by setting up an international control organ having powers on which there is immediate agreement", and that it would then be possible to find acceptable compromises on the remaining points of difference. It calls upon the British Government to make a more positive approach to the solution of these problems.

The area of agreement is stated to be as follows: "All countries are agreed on the urgent necessity of an international control scheme of some kind. All countries agree that when such a scheme is functioning no atomic weapons should be in the hands of any national authority. All agree that the international control authority should have its own rules of procedure and that there should be no right of veto in the day-to-day functioning of the authority. All agree that the international control authority should have its own inspection staff which should be chosen on an international principle and have full inspection rights in any establishment in any country concerned with obtaining atomic war materials and producing atomic materials and atomic energy. All agree that the international control authority should be empowered to conduct special investigation on cases when it is suspected that illicit material is being produced, and that it should be given facilities by the State concerned to conduct the necessary investigations. All agree that the international control authority must have the positive functions of operating research establishments staffed by its own qualified international personnel so that it will keep abreast of the latest scientific developments in the field of atomic energy." Although the statement suggests lines of compromise on several contentious aspects of the problem, it does not attempt to show how the points of agreement could provide a practical basis for an international organ before the points of disagreement are resolved.

Controlled Fast Neutron Chain Reaction

IT has been announced that a "fast fission pile" is in operation at the Los Alamos Laboratory of the United States Atomic Energy Commission. Instead of using natural uranium, in which a chain reaction can be maintained only with the aid of a 'moderator' that brings the energies of most of the neutrons into the thermal region, this pile employs plutonium and has no moderator, the reaction being maintained (as in the atomic bomb) by fast neutrons. It may be explained that the possibility of controlling such a pile arises from a time lag between the fission process and the emission of the small but appreciable proportion of the neutrons that come from the radioactive products of fission. The pile will be a valuable source of fast neutrons for experimental purposes.

Literature on Atomic Physics

IN the April–May issue of the *Bulletin of Atomic Scientists* the editors present a new section which, it is intended, will contain information concerning articles and books of interest on atomic energy. The first contribution is a bibliography surveying the literature now available. M. C. Leikend, who is consultant in science on the staff of the Library of Congress, has compiled a bibliography which covers the period March 1, 1946–February 1, 1947, and which is printed, by permission of the Library of Congress, on pages 127–35 of the *Bulletin*. The

alphabetical list contains 284 references, and supplements the bibliography of "Books and Articles on Scientific and Political Aspects of Atomic Energy" which was published in the Report of the Special Committee on Atomic Energy, U.S. Senate, issued in 1946. The editors, in addition, direct attention to the list of the first 270 atomic energy papers to be declassified by the Atomic Energy Commission or by its predecessor, the Manhattan Engineering District, details of which can be obtained from the Office of Technical Services, U.S. Department of Commerce (see also p. 445 of this issue).

New Quarterly Journal of Mechanics and Applied Mathematics

It has long been felt that there is a need in Great Britain for a journal devoted to classical mechanics. At present papers on this subject can only be published in journals such as the *Proceedings of the Royal Society* and the *Philosophical Magazine*, which are already overloaded with other subjects. The existence of such a journal would have a stimulating effect on scientific and technical education, as similar publications have had in Germany and the United States. The topics which would come within the scope of such a journal would include: hydrodynamics, including aerodynamics, sound and dynamical meteorology; elasticity and plasticity; numerical methods, including calculating machines and relaxation methods; non-linear dynamics; ballistics; classical electromagnetism, including the propagation of electric waves in space and in wave-guides. Contributions on these subjects are likely to contain references to published experimental work; and when new experimental work is undertaken in this connexion, it might be suitable for publication in the journal.

An editorial board consisting of Prof. S. Goldstein, Dr. R. V. Southwell, Sir Geoffrey Taylor, Prof. G. Temple, and other eminent British investigators in these fields has been formed, and a new periodical to be called *The Quarterly Journal of Mechanics and Applied Mathematics* is to be published. The business connected with the *Journal* will be conducted by two executive editors, Dr. V. C. A. Ferraro (University College, Exeter) and Dr. G. C. McVittie (King's College, London). The Oxford University Press has undertaken to publish the *Journal*, and it is intended to issue the first number in April 1948. Papers to be considered for one of the early issues should be sent before December 1947, addressed by name to one or other of the executive editors, at King's College, Strand, London, W.C.2.

Photostat Copies of German Scientific and Technical Papers

Arrangements have been completed for a photostat service to provide workers in Great Britain with the full text of papers appearing in current German scientific journals. A very full list of current German scientific and technical journals is now being sent regularly to the Bureau of Abstracts, which is working in close harmony with other British abstracting bodies, in particular the Institution of Electrical Engineers, to ensure the most complete cover possible in abstracting all significant papers appearing in these journals. Any British scientific man who desires to consult the full text of a German article referred to in a British abstract publication should write direct to Research Branch ECOSC (Photostat Service), 77 H.Q. C.C.G. (BE), AVA-Göttingen, B.A.O.R., with his request. A simple *pro forma* system has been devised whereby the photostats are prepared in Germany, and payment is made in sterling to the Director of Accounts, Photostat Service, Foreign Office (German Section), Norfolk House, St. James's Square, S.W.1. The charge is one guinea for ten pages, 2*s*. 6*d*. per page thereafter.

Institute of Navigation

The first annual general meeting of the Institute of Navigation was held on September 19 in the house of the Royal Geographical Society. The officers and council of the Institute were elected for the ensuing year; the Astronomer Royal, Sir Harold Spencer Jones, was elected president, and Air Chief Marshal Sir John Slessor and Sir Robert Watson-Watt were elected vice-presidents. Messages of support for the Institute were received from the First Sea Lord and the Chief of the Air Staff. In his address to the Institute, Sir Harold Spencer Jones reviewed the important contribution that, from the time of the foundation by Charles II of the Royal Observatory to the present day, had been made by British scientific work towards the solution of navigational problems. "The first systematic observations to provide the fundamental astronomical data with the required precision; the construction of the first magnetic charts; the invention of the quadrant or sextant . . .; the publication of the first Nautical Almanac planned specifically for the use of the navigator; the invention of the first timepiece capable of keeping accurate time at sea. These are all achievements on which we can look back with pride and satisfaction." He pointed out that it is appropriate, as Great Britain took so prominent a part during the past centuries in the development of navigation as a science, that the Institute of Navigation should have been formed to foster an interest in navigation and to stimulate its advancement. There are still many problems to be solved and, in particular, those presented by the advent of high-speed aircraft have necessitated changes of method. In bringing together those who are interested in the many and varied aspects of the science of navigation, the Institute will fulfil a useful function.

After the president's address, two papers were read to the Institute: "The navigational work of the Nautical Almanac" by D. H. Sadler, superintendent of the Nautical Almanac; and "Wind Statistics and their Relation to Air Line Operation" by Captain E. Brook Williams, superintendent of navigation, British Overseas Airways Corporation. The Institute, which has its offices at the Royal Geographical Society, was formed six months ago "to unite in one scientific society those interested in the science of navigation". Its formation was stimulated by the formation in 1945 of a similar body in the United States. Institutes have either been formed or are in the process of formation in Belgium, Denmark, Holland and Sweden.

A Projected International Institute for Amazonian Studies

On August 12 a conference began in Belém, Brazil, at the mouth of the Amazon, which carried a stage further the proposal, made to the United Nations Educational, Cultural and Scientific Organisation last year, that inquiries be made into the possibility of setting up an international institute for investigating as a whole the enormous rain-forest area of tropical South America. Apart from the Antarctic continent, this area is less known than any other in the world; and data in all subjects, from physical

geography to anthropology, are few in spite of the classical expeditions of Humboldt, Wallace, Bates and their successors. It includes the greater part of northern, central and western Brazil and parts of Bolivia, Colombia, Ecuador, Peru and Venezuela, and British, French and Dutch Guiana, and is conveniently called by Humboldt's name, the Hylean (forested) Amazon.

At the Belém meeting all the countries mentioned above were represented, mostly by experts in various fields, with the exception of the Netherlands; in addition, the United States sent Dr. Bassett Maguire, of the New York Botanic Garden, and Dr. Remington Kellogg, of the Division of Mammals of the Smithsonian Institution. Dr. Fred L. Soper, of the Pan-American Sanitary Bureau, best known for his work in the suppression of yellow fever in eastern South America, was elected president of the meeting; the secretary was Dr. E. J. H. Corner, for many years at the Botanical Gardens at Singapore and now principal field scientific officer for the United Nations Educational, Scientific and Cultural Organisation in Latin America, and his assistant was Dr. B. Malamos, a Greek specialist in tropical medicine. The conclusions reached at Belém will be considered at the next annual meeting of the United Nations Educational, Scientific and Cultural Organisation, to be held at Mexico City in November. In summary, they are that the scientific investigation of the Hylean region is well fitted for international collaboration and can scarcely be carried out in any other way; that science should be taken to include the social sciences as well as the physical and biological sciences and medicine; and that the next step, if an institute can be financed and its foundation is approved, is to set up a small body of experts to do full-time work on planning.

British Bryological Society

Members of the British Bryological Society assembled at Kirriemuir, Angus, during September 3–10 for the annual general meeting and excursion. Under the leadership of Miss U. Duncan, excursions were made to the Sidlaw Hills, the Loch of Kinnordy, the Den of Airlie, Glen Clova and Barry Sands. Two days were devoted to the investigation of localities in Glen Clova; the first to Loch Brandy and the cliffs above, and the second day to the Fee Burn area. Small parties also went to Glen Isla and Glen Prosen. Many interesting bryophytes were studied, and the results of the field-work will be published in the next part of the *Transactions* of the Society. Mr. A. Thompson was elected president, with Dr. P. W. Richards as vice-president, for 1947–48. Mr. E. C. Wallace was elected honorary secretary.

The Night Sky in October

New moon occurs on Oct. 14d. 06h. 10m., U.T., and full moon on Oct. 29d. 20h. 07m. The following conjunctions with the moon take place: Oct. 8d. 21h., Mars 4° S.; Oct. 9d. 22h., Saturn 5° S.; Oct. 16d. 04h., Mercury 4° S.; Oct. 17d. 05h., Jupiter 1° N. In addition to these conjunctions with the moon, Mercury is in conjunction with Venus on Oct. 29d. 09h., Mercury being 2·7° S. Mercury and Venus are evening stars but set too soon after the sun for favourable observation. Mars, in the constellation of Cancer, can be seen during the morning hours, rising at 23h. 37m., 23h. 25m., and 23h. 09m., at the beginning, middle, and end of the month, respectively. Jupiter, in the constellation of Scorpius, is visible only during the early portion of the night, setting at 19h. 17m., 18h. 29m., and 17h. 35m., at the beginning, middle, and end of the month, respectively, in the last case just an hour after sunset, and at this time it is very close to β Scorpii. Saturn, in the constellation of Leo, cannot be seen until the early morning hours, rising at 1h. 26m., 0h. 38m., and 23h. 42m., at the beginning, middle, and end of the month, respectively, and can be easily identified by its position with reference to Regulus, of which it is a little west. An occultation of only one star brighter than magnitude 6 takes place: October 4d. 3h. 17·8m., 13 Tauri (*R*), the latitude of Greenwich being assumed and *R* referring to reappearance. The Orionid meteors are active from about October 18–26, but towards the end of this period moonlight will partly interfere with the observations. On October 26 the moon sets at 2h. 14m.

Announcements

The Tilden Lecture of the Chemical Society will be delivered by Prof. E. G. Cox, professor of chemistry in the University of Leeds, in the Society's rooms on October 23; he will speak on "Crystallographic Technique and its Chemical Significance".

Mr. P. A. Wells, general secretary of the Society of Dyers and Colourists, has been appointed director of education in the International Wool Secretariat, London.

Dr. W. T. H. Williamson, director of the Agricultural Department of the British Council since its formation in 1945, has been appointed lecturer in charge of the newly established Department of Soil Science in the University of Aberdeen. During the War, Dr. Williamson was adviser in agricultural chemistry in the University College of South Wales, Monmouthshire. Previously, he was for eleven years chief chemist to the Ministry of Agriculture in Egypt.

Mr. B. J. Mason, of University College, Nottingham, has been awarded a Shirley fellowship by the British Cotton Industry Research Association. Mr. Mason will work under the direction of Prof. L. F. Bates and Dr. G. D. Yarnold at University College, Nottingham, on the hysteresis of the contact angle of liquids against solids, and will take up the fellowship immediately. The fellowship awarded in October 1946 to Mr. G. W. Ross, of the University of Aberdeen, has been extended for a further year. Mr. Ross is working on polymerization in the liquid phase under the direction of Prof. H. W. Melville.

On September 16, at Bonneville Salt Flats, Utah, Mr. John Cobb set up a world speed record for motor-cars of 394·196 miles an hour.

The second general meeting of the Gesellschaft Deutscher Chemiker in der Britischen Zone will take place at Bonn during October 7–9. The advance programme is not yet available, but it is known that a wide range of chemical topics will be discussed. Accommodation for foreign guests in Bonn is severely limited; no further applications can be considered.

The Women's Legion and the Women's Engineering Society announce the foundation of a new scholarship in aeronautical engineering for women. It will be awarded every two years, girls between the ages of fifteen and twenty being eligible. Application forms, to be returned before April 30, 1948, can be obtained from the Secretary, Women's Engineering Society, 35 Grosvenor Place, London, S.W.1, to which all inquiries should be made.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Influence of Climatic Conditions on Autumn Calvings

ANALYSIS of the sales of surplus calves to Ministry of Food collecting centres in West Wales during the four years 1943–46 reveals the interesting fact that there is a fall in the percentages sold during the autumn months (September–December) from coastal to inland centres and from centres in the west to those in the east. Autumn deliveries to the milk depots in the region show the same trends: thus factory *F* in the west received during the month of December (average of the four years 1943–46) 94·6 per cent of its September deliveries, whereas factories *C*, *D* and *G* in the eastern areas received only 53·9, 52·7 and 52·1 per cent respectively. There is therefore considerable evidence that the coastal areas, and particularly West Pembrokeshire, have a higher incidence of autumn calvings.

It is believed that these variations are due not to differences in herd management as such but to environmental factors beyond the farmer's control, and particularly to climatic conditions during the months of relevant conceptions, namely, December–March. There is already evidence[1,2,3] in Great Britain that the duration of œstrus and probably the general fertility of cattle vary through the year with temperature, sunshine or both. If such differences can be caused by variation in climate through time, it is likely that they can be caused by variation in climate through space, and, in fact, the degree of winter fertility in West Wales appears to vary with both temperature and sunshine.

The accompanying map, on which the 42° F. isotherm for January has been superimposed, indicates percentage sales of surplus calves during the autumn months (and the location of the milk depots). To the west of this isotherm the average January temperature rises to nearly 45° F. in some areas, whereas to the east it falls to below 39° F. in some inland districts.

Data for sunshine are scanty; but the distribution almost certainly follows the isotherm in general outline, and the amount declines sharply inland to the east. There is a marked coincidence between the area with a mean January temperature of more than 42° F. and the area with more than 30 per cent of calves produced during the autumn months.

These findings, which form part of a survey of animal health and production in West Wales, supported by a grant from the scientific branch of Messrs. Cooper McDougall and Robertson, Berkhamsted, will be published in detail elsewhere.

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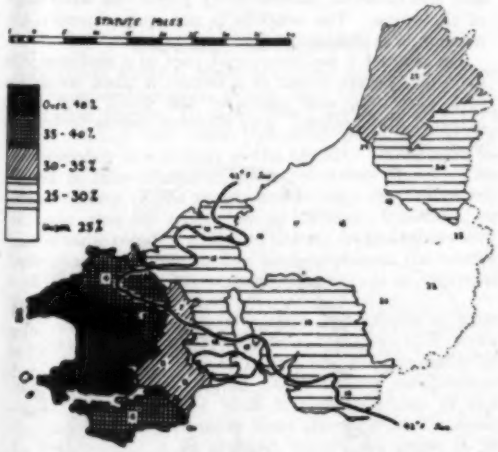
July 27.

[1] Hammond, J., "Reproduction in the Cow" (Edinburgh, 1927).
[2] Laing, J. A., *J. Agric. Sci.* (1945).
[3] Wilson, S. G., *J. Agric. Sci.* (1946).



1 Croesgoch, 44
2 Hasguard, 41
3 Haverfordwest, 40
4 Mathry Road, 37
5 Clarbeston Rd., 37
6 Pembroke, 36
7 Clynderwen, 30
8 Narberth, 31
9 Kilgetty, 34
10 Cardigan, 28
11 Crymmych, 27
12 Whitland, 28
13 Carmarthen, 26
14 Kidwelly, 28
15 St. Clears, 24
16 Newcastle Emlyn, 25
17 Llandyssul, 22
18 Llanybyther, 20
19 Lampeter, 23
20 Tregaron, 26
21 Llandilo, 21
22 Llangadock, 25
23 Llandovery, 21
24 Ystrad, 24
25 Aberystwyth, 31

PERCENTAGE OF CALVES SOLD IN WEST WALES COLLECTING AREAS IN THE FOUR-MONTH PERIOD SEPTEMBER–DECEMBER FOR FOUR YEARS 1943–46 WITH 42° F. JANUARY ISOTHERM SUPERIMPOSED. THE ACTUAL PERCENTAGE FIGURE IS GIVEN AFTER THE NAME OF EACH CENTRE

Influence of Variation in Length of Day upon the Breeding Season in Sheep

ALTHOUGH it is well known that sheep, and particularly those of British origin, are seasonal breeders, there has been a lack of definite knowledge of the cause of this.

It has been shown[1] that the breeding season in the ferret is controlled by length of day and that light is the effective agent, causing anterior pituitary activity[2], due in all probability to stimulation from an optico-hypothalamic relay.

In the British Isles, sheep breed in the autumn and winter months, and when transferred to countries in the southern hemisphere they reverse their time of breeding to conform to the new seasons[3]. This is evidence that in these animals the phenomenon of seasonality in breeding is due chiefly to some stimulus of the natural environment rather than to an inherent rhythm. There is some evidence[4] to suggest that seasonal change in length of day is the effective agent, and in the goat, also, experimental work[5] points in this direction.

In an endeavour to elucidate the problem, experiments were commenced in September 1946. The results so far available seem to warrant reporting and may be summarized as follows.

The natural breeding season of a control group of highly fertile Suffolk × Border Leicester–Cheviot ewes commenced in September, some 10–14 weeks after the longest day. In the absence of pregnancy the ewes continued to accept service from vasectomized rams at regularly recurring intervals of 16–17 days right up to the end of March, or some 10–14 weeks after the shortest day. Thereafter anœstrum ensued.

A group of similar sheep, subjected to artificial irradiation with strong electric light in such a way that their daily quota of light rose gradually from nearly thirteen hours in mid-October to twenty-one hours at the end of January, ceased breeding two months before the control group, but likewise 10–14 weeks after their shortest day, which was in mid-October.

After the end of January these same sheep had their daily quota of light reduced gradually from twenty-one hours to just under fourteen hours by March 21. Thereafter, this reduction was maintained by enclosing them in a blacked-out pen at appropriate times each day, until by the third week of June they were receiving daily only 5½ hours of light. The sheep in this group commenced breeding on May 20, and within twenty-two days all were in full breeding state, including those which had lambed only ten weeks previously. Those ewes running with the vasectomized rams are now (July 1947) returning for service every 16–17 days, while those which have been served by a fertile ram appear to have settled to a pregnancy normal in every way except the time of year of its commencement.

A further group of ewes was introduced into the experiment on March 23. They had been under the influence of the naturally lengthening days from late December to late March, at which time they joined the other experimental group of sheep. They had thus reached a quota of nearly fourteen hours of light per day, when they were submitted to a gradual decrease. This group of ewes commenced breeding on June 28, again 10–14 weeks after their longest day.

From these results it appears evident that: (*a*) Seasonal variation in length of day is the chief factor determining the time of onset and the duration of the natural breeding season in sheep. (*b*) This natural breeding season can be modified and even reversed at will by altering artificially the length of day. (*c*) A change from increasing length of day to decreasing length of day induces reproductive activity, the breeding response occurring 10–14 weeks after the change. (*d*) A change from decreasing length of day to increasing length of day induces anœstrum 10–14 weeks after the change. (*e*) A change from decreasing length of day to increasing length of day is apparently just as effective at a level of 12½ hours as it is at a level of nine hours in inducing anœstrum. Similarly, a change from increasing length of day to decreasing length of day is apparently just as effective at a level of 13½ hours as it is at a level of twenty-one hours in inducing reproductive activity.

This work, which is still in progress, is being carried out while holding a Walter and Eliza Hall Travelling Scholarship from the University of Queensland. Detailed results of the work will be published elsewhere at a later date. Sincere thanks are tendered to Dr. John Hammond for his encouragement and advice.

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[1] Bissonnette, T. H., *Proc. Roy. Soc.*, B, **110**, 322 (1932).
[2] Hill, M., and Parkes, A. S., *Proc. Roy. Soc.*, B, **113**, 537 (1933).
[3] Marshall, F. H. A., *Proc. Roy. Soc.*, B, **122**, 413 (1937).
[4] Hammond, J., jun., *J. Agric. Sci.*, **34**, 97 (1944).
[5] Bissonnette, T. H., *Phys. Zool.*, **14**, 379 (1941).

Ascorbic Acid Content of Whale's Milk

During whaling operations in the Antarctic, opportunity arose to carry out an ascorbic acid estimation on a fairly fresh sample of whale milk. The sample, about 200 c.c., was drawn from the main duct of one of the mammary glands of a lactating fin whale (*Balænoptera physalus*) which had been dead not more than six hours. Fresh whales are not common on a factory, and lactating whales are protected, so that the occurrence of a fairly fresh lactating whale is comparatively rare.

Ascorbic acid was estimated on the filtrate from trichloracetic acid precipitation of the milk, using 2 : 6 dichlorophenol indophenol as indicator. Results gave an ascorbic acid content of about 7 mgm./100 ml. for the original sample. (Figures for human milk are 4–8 mgm./100 ml. and for cow milk around 1–4 mgm./100 ml.) Unfortunately, it was not possible to estimate the vitamin C present in the krill on which the whale feeds.

My thanks are due to "Discovery" Investigations for the opportunity of going south, and to United Whalers, Ltd., for their hospitality.

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July 24.

Further Remains of the Sterkfontein Ape-man, *Plesianthropus*

At the beginning of April we restarted work at Sterkfontein in the search for more remains of *Plesianthropus*; and we were successful in getting remains of a number of individuals and a perfect skull of an elderly female, of which an announcement was made in *Nature* of May 17. Unfortunately, owing to a difference of opinion with the Historical Monuments Commission, further work was delayed for a month.

On June 24 we discovered the nearly complete and fairly well preserved lower jaw of a large middle-aged male. With it were found part of a maxilla and much of a humerus and scapula. The humerus has the head perfect, and most of the shaft is also present but badly crushed. The distal end is lost. The head of the humerus is practically human in size and structure. The scapula has the glenoid portion and the coracoid satisfactorily preserved with much of the spine. The scapula is not quite human, but neither is it anthropoid.

On August 1 we discovered part of a skeleton with a perfect pelvis, much of a femur, a tibia, some ribs and vertebræ, and parts of the skull very badly crushed and broken. The skeleton seems to be that of a female.

A B C

A. Right side of pelvis of *Plesianthropus transvaalensis* Broom.
B. " " " large male chimpanzee.
C. " " " male Bushman.
All ¼ natural size.

The pelvis, as will be seen from the accompanying drawing, has an ilium which is almost typically human. It is shaped almost exactly as in the Bushman, and very unlike that of any of the anthropoids or monkeys. Had this ilium been found alone, some would probably have claimed it as human, though no one would have been likely to have argued that it was only a chimpanzee pelvis. Fortunately, the ischium is well preserved, though the lower part is crushed; and certainly the ischium is not quite human. The tuberosity is flattened in a different way from the condition in man.

The pubis is quite well preserved, though a little crushed and displaced in front. It agrees fairly well with that of man. There are a number of minor differences from man in the obturator region.

The femur is much crushed, and has not yet been removed from the matrix. It is rather slender, and has a few characters not quite human. The distal end is lost, but the bone when complete was probably about 250 mm. in length. The tibia is imperfect and much crushed. It was probably about 230 mm. in length. The skeleton was probably that of a female who stood about 4 ft. in height or a little less. The male must have been much taller—perhaps even 5 ft.

The discoveries so far made seem to leave no doubt that the Australopithecines were a group of higher Primates closely allied to man, who had practically human teeth and who walked on their hind limbs. Though their brains were small, they seem to have been more human than anthropoid in structure. The conclusion to which some of us have come, namely, that man has evolved from an Australopithecine of Pliocene times, seems likely to be proved to be correct.

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Daphnia Hæmoglobin

In Great Britain there are three common species of *Daphnia* living in ponds and ditches, namely, *D. magna* Straus, *D. pulex* (De Geer) and *D. obtusa* Kurz. They are often coloured pink or red by hæmoglobin in solution in the blood[1]. Other species, found in lake plankton, have colourless blood. The blood of any of the pond species may vary from red to pale pink or colourless in different localities, or in the same pond at different times. In the laboratory individuals can gain or lose hæmoglobin in the course of a few days. When anæmic, *Daphnia* is as vigorous as when its blood is red.

In order to study the causes and effects of this fluctuation in quantity of blood pigment, I have worked out a method of estimating the quantity of hæmoglobin in individual *Daphnia*, by comparison under the microscope with known dilutions of my own blood. Experiments have shown that *Daphnia* loses hæmoglobin in aerated water and gains it in water with a paucity of dissolved oxygen. It behaves like a mountain climber. Deficient oxygen is, however, not the only cause of hæmoglobin synthesis, for water taken from a pond containing red *Daphnia* can increase the hæmoglobin in pale animals even when the water is well aerated. It is hoped to isolate the responsible substance in the pond water.

In the laboratory, starved *Daphnia* will not synthesize hæmoglobin in water lacking oxygen, while well-fed animals will do so; yet good nutrition alone is not the cause of red blood. Abundance of parthenogenetic eggs are a sign of good nutrition; but in the field there is no relation between egg number and blood colour. It has been thought that chlorophyll in the food of *Daphnia* is the cause of hæmoglobin synthesis[2]; I find no evidence for this.

It is not yet known how hæmoglobin is excreted when *Daphnia* loses the pigment. In the lumen of the gut a hæmochromogen is present which is reversibly oxidized and reduced as the hæmoglobin in the blood is oxygenated and deoxygenated according to the pressure of dissolved oxygen in the water outside. This hæmochromogen is proportional in concentration to the blood pigment, which suggests that it may be a breakdown product of the hæmoglobin. Yet this same hæmochromogen is found in the lake plankton species *D. hyalina* Leydig, the blood of which has no detectable hæmoglobin. Occasionally one of the two excretory shell glands in pond species is full of very concentrated hæmoglobin; this pathological hæmoglobinuria suggests that hæmoglobin may normally leak out as such through the excretory organs.

The increase of blood pigment in response to external oxygen deficiency points to a respiratory function. Yet *Daphnia*, the hæmoglobin of which is functionally inactivated for oxygen transport by means of carbon monoxide, swims as vigorously and survives just as long as untreated animals, at all concentrations of dissolved air down to the lowest that can be supported. There is thus no obvious respiratory function of the blood pigment.

It is known that the parthenogenetic eggs of *Daphnia* contain hæmoglobin[3]. Has this a function? A use would be suspected for it since respiratory conditions in the brood pouch are not perfect. This is seen as follows: when an individual *Daphnia* deoxygenates its hæmoglobin beneath a cover slip, the microspectroscope shows that the oxyhæmoglobin bands disappear in the eggs before they go from the blood. This difference is not due to a lower oxygen affinity of egg hæmoglobin because, when the eggs are removed from the brood pouch, their hæmoglobin retains its oxygen as long as that in the blood stream. It must be that the oxygen supply is faulty in the brood pouch. Experiments showed that when the hæmoglobin of parthenogenetic eggs with developing embryos is converted into carboxyhæmoglobin, the rate of development of the eye is retarded in its later stages. To this extent, at least, the possession of oxyhæmoglobin by the egg is advantageous.

Unlike parthenogenetic eggs, the fertilized ova contain no hæmoglobin. This is the case however much there may be in the mother's blood. It might be thought that in these eggs hæmoglobin is unnecessary since the oxygen supply must be better in ephippia than in the brood pouch. Yet experiments showed that ephippial eggs develop and hatch as quickly at a low concentration of dissolved oxygen as they do in aerated water.

Since the hæmoglobin in the blood has apparently no respiratory function, whereas it is functional in the development of parthenogenetic embryos, the pigment in the blood might merely be an overflow from the supply to the eggs. In this case females reproducing bisexually should have less hæmoglobin in their blood, or none. But this is not so; ephippial females have as much blood pigment as parthenogenetic mothers in the same population.

May it not be that hæmoglobin still appears in the blood of *Daphnia* as a functionless by-product of metabolism, as it must once have done in the early history of animals, before natural selection seized upon its potentially valuable property of reversible oxygenation ?

These results will be published in detail shortly. The investigation is being continued.

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[1] Lankester, E. R., *Pflüg. Arch. ges. Physiol.*, **4**, 315 (1871).
[2] Verne, J., *Bull. Soc. Zool. Fr.*, **48**, 140 (1923).
[3] Teissier, G., *C.R. Soc. Biol. Paris*, **109**, 813 (1932).

Technique for Rearing Thrips in the Laboratory

Methods of rearing thrips in the laboratory have been described by Bailey[1] and Rivnay[2], among others. The following simple technique differs from their methods, and has been used with success at the Imperial College of Tropical Agriculture for work on the cacao thrips, *Selenothrips rubrocinctus* (Giard). Several other thrips, such as *Dinurothrips hookeri* Hood, *Hercothrips insularis* Hood and *Heliothrips hæmorrhoidalis* (Bouché), have also been reared by this method for life-history studies.

Thrips were reared in small solid watch glasses or small Petri dishes. The watch glasses were of the type used for embryological work and measured 40 mm. square with a cavity 32 mm. in diameter and 10 mm. deep. They were provided with close-fitting square glass covers. The Petri dishes were 50 mm. in diameter and 10 mm. in depth. A small piece of blotting paper was placed in the bottom of each watch glass or Petri dish and kept slightly moist.

Disks 18 mm. in diameter were cut from appropriate fresh leaves by means of a large cork borer. These leaf disks were used as food material, being placed on the blotting paper, which was kept no more than slightly damp. When conditions were too wet, moulds developed and the leaf disks rotted in a day or two. In favourable circumstances they remained in good condition and served as food for about a week or longer.

With this technique it was possible to make constant observations of all developmental stages of the thrips. Leaf disks could be readily removed from the watch glass or Petri dish with a pair of forceps, and the eggs, larvæ and other stages examined under a hand lens or binocular microscope. The immature stages and adults could be transferred when necessary to a fresh leaf disk by lifting them with a fine damp sable-hair paint-brush placed carefully beneath the abdomen. With care even the very delicate newly hatched first instar larvæ could be transferred in this way without injury.

No originality is claimed for the above method, but the following flotation technique appears to be new. This is a modification in which the cavity of the watch glass or lower Petri dish is filled with water or a nutrient solution and the leaf disk is floated on the surface of the liquid. Glass covers are unnecessary, as the immature stages at least show no inclination to leave the floating disk, due to the surrounding fluid. Adults of species such as the cacao thrips have little tendency to flight, but in others the adults fly readily from the leaf disks. If glass covers are used to prevent their escape, they usually become trapped in the liquid on which the disks float or in the condensed moisture on the inside of the covers.

An advantage of this flotation method is that the leaf disks remain fresh for an extended period, even for the duration of the life-cycle of the thrips. Disks containing eggs can therefore be cut from the leaves of infested plants and serve as food for the immature stages throughout their life. Stephenson[3] has shown that leaves from cacao plants grown with cultural solutions containing more than 50 p.p.m. of potassium are distasteful to the cacao thrips. The use of the disk flotation method with nutrient solutions instead of water may make it possible to compare the effect of various solutions on the palatability to thrips and other small sucking insects of small samples of their food material.

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[1] Bailey, S. F., *J. Econ. Ent.*, **25**, 1194 (1932).
[2] Rivnay, E., *Bull. Ent. Res.*, **26**, 267 (1935).
[3] Stephenson, P. R., Dissertation, Imp. Coll. Trop. Agric., Trinidad (unpublished, 1938).

'Water Excretory Threshold' as a Measure of Kidney Efficiency

In 1926 Rehberg[1] suggested that the function of a kidney might be measured by the extent to which intravenously administered creatinine could be concentrated during the elaboration of the urine. He also claimed that the creatinine clearance measured quantitatively the glomerular filtrate.

Comparison of the simultaneous creatinine and inulin clearances[2] gave rise to the view that creatinine was secreted by the renal tubules, since its clearance exceeded that of inulin. However, this discrepancy has been shown[3] to be due to the fact that the method of estimating creatinine used in these studies was not specific. If a sufficiently specific method be used, the endogenous creatinine clearance agrees with the inulin clearance and can, therefore, be safely assumed to measure glomerular filtration-rate.

Glomerular filtration-rate may, therefore, be expressed in symbol form as $U.V/P$, where U is the urinary concentration of creatinine, P the plasma concentration of creatinine and V the minute-volume of urine. The amount of fluid reabsorbed then becomes

$$\frac{U.V}{P} - V.$$

Barclay and Cooke[4] showed that for electrolytes a value for a reabsorptive threshold, or 'threshold plasma-level'[5], could be obtained by referring the amount reabsorbed per minute to a constant rate of glomerular filtration. A similar method may be used in the case of water reabsorption, and so obtain a value for the volume of water reabsorbed from each ml. of glomerular filtrate.

$$R = \frac{\frac{U.V}{P} - V}{U.V/P}.$$

Let $U/P = C$ (the concentration ratio of Rehberg).

$$\text{Then } R = \frac{C.V - V}{C.V} = 1 - \frac{1}{C}.$$

The values for water threshold R will range, therefore, from *c.* 0·995 for a urine flow of 0·5 ml./min. to *c.* 0·8 for a urine flow of 20 ml./min.

In order to obtain a more useful scale of values, we suggest the use of the expression $1/C$ and the multiplication of the values by 10^3. These values then express the volume of urine excreted from each 1,000 ml. of glomerular filtrate and can be obtained without knowing the volume of urine formed per minute. In this way, the concentrating power of the kidney towards water can be obtained from samples of urine without any precautions for complete collection of the sample. The fact that no injections or accurate urine sampling are required make this a useful tool in the clinical examination of renal disease, and when the values for 'water excretory threshold' are taken in conjunction with values of the index E [6] for the various urinary solutes, one obtains a reliable assessment of the power of the kidney to deal with the normal urinary constituents and the extent of any glomerular or tubular damage.

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[1] Rehberg, P. B., *Biochem. J.*, **20**, 447 (1926).
[2] Smith, H. W., "Physiology of the Kidney" (Oxford Medical Publications, London, 1937).
[3] Barclay, J. A., and Kenney, R. A., *Biochem. J.*, in the press.
[4] Barclay, J. A., and Cooke, W. T., *Nature*, **154**, 85 (1944).
[5] Barclay, J. A., Cooke, W. T., and Kenney, R. A., *Acta Medica Scandinavica*, in the press.
[6] Barclay, J. A., and Kenney, R. A., *Acta Medica Scandinavica*, **125**, 385 (1946).

Absence of Hyaluronidase from Reptilian Testes

The occurrence in mammalian testes and aqueous extracts of spermatozoa of a substance causing increased spread of fluids injected intradermally was described by Hoffman and Duran-Reynals[1], and McClean[2]. These observations have since been confirmed by numerous workers[3], and the 'spreading factor' has been shown to be identical with the enzyme hyaluronidase first described by Meyer, Dubos and Smythe[4]. The work of McClean and Rowlands[5], Fekete and Duran-Reynals[6], and others has indicated the probable role of seminal hyaluronidase in the fertilization process, namely, solution of the gel cementing the follicle cells around freshly ovulated ova, thereby denuding the latter and so enabling spermatozoa to penetrate them. In human semen, a close correlation has been shown to exist between sperm density and hyaluronidase content, azoospermic semen being devoid of the enzyme[7,8,9]. It has also been shown that a similar relationship holds in the case of the bull, rabbit and boar, though not in the dog or fowl[9]; in the dog, the hyaluronidase content of semen was found to be small and seemed to vary independently of the sperm density, while in the fowl it was absent altogether from six out of ten samples tested and appeared to be present in the remainder in trivial amounts only.

The interest of the findings in fowl semen lay in the fact that in birds the ova are never surrounded by follicle-cell cumuli; in other words, according to the hypothesis outlined above, the presence of hyaluronidase would not be necessary to enable fertilization to occur. Since reptilian ova, like those of birds, are also devoid of cumuli when ovulated, it seemed well worth while to determine whether or not reptiles produce seminal hyaluronidase. Assay of semen in this case was out of the question, and it was consequently decided to extract reptilian testes according to a method known to give high yields of the enzyme from rabbit testes[9]. Briefly, this consisted in grinding the testes (which had been kept on ice for not longer than 48 hours until ready for use) with sand, extracting with water at 0° C. and filtering the extract. The extracts were tested for hyaluronidase activity by the viscosimetric method described by Swyer and Emmens[10].

The nature of the testicular material used is shown in the table; in all cases the animals, so far as could be ascertained, were sexually mature. In no case was any hyaluronidase detectable in the extracts.

	Species	Moist weight of testes (gm.)	Total volume of extract (ml.)
1	Anaconda (*Eunectes murinus*)	2·86	25
2	" " "	4·34	25
3	" " "	3·64	25
4	Flap-necked chameleon (*Chamaleon dilepis*)	0·193	10
5	*Python regius*	0·56	10
6	River Jack viper (*Bitis gabonica*)	1·35	10
7	" " " "	0·465	10
8	Margouillat lizard (*Agama agama*)	0·25	10
9	Green mamba (*Dendraspis viridis*)	0·21	10

The absence of hyaluronidase from reptilian testes is, of course, in accord with the hypothesis mentioned above, and may therefore be regarded as additional support for it.

My sincere thanks are due to the Zoological Society of London for providing the reptilian material used.

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[1] Hoffman, D. C., and Duran-Reynals, F., *J. Exp. Med.*, **53**, 337 (1931).
[2] McClean, D., *J. Path. Bact.*, **32**, 1045 (1930); *J. Path. Bact.*, **34**, 459 (1931).
[3] Chain, E., and Duthie, E. S., *Brit. J. Exp. Path.*, **21**, 324 (1940). Humphrey, J. H., *Biochem. J.*, **37**, 177 (1943). McClean, D., *Biochem. J.*, **37**, 169 (1943).
[4] Meyer, K., Dubos, R., and Smythe, H. M., *J. Biol. Chem.*, **118**, 71 (1937).
[5] McClean, D., and Rowlands, I. W., *Nature*, **150**, 627 (1942).
[6] Fekete, E., and Duran-Reynals, F., *J. Exp. Med.*, **53**, 387 (1931).
[7] Joël, C. A., and Eichenberger, E., *Schweiz. med. Wschr.*, **27**, 601 (1945).
[8] Wertheesen, N. T., Berman, S., Greenberg, B. E., and Gargill, S. L., *J. Urol.*, **54**, 565 (1945).
[9] Swyer, G. I. M., *Biochem. J.*, in the press.
[10] Swyer, G. I. M., and Emmens, C. W., *Biochem. J.*, **41**, 29 (1947).

Adsorption Analysis of Oxidized Insulin

A special modification of adsorption chromatography on charcoal has been shown by Tiselius[1] to be a useful and selective method of analysis for mixtures containing closely related substances. The method was originally designed for the investigation of breakdown products of proteins, though it has not yet been extensively applied to relatively high-molecular polypeptides, since these are often such complex mixtures as to render any type of analysis extremely difficult.

The oxidation of insulin with performic acid yields a product in which it was believed that the molecule was split into its separate polypeptide chains[2]. This

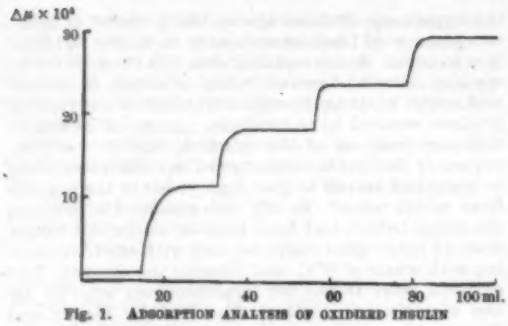

Fig. 1. Adsorption analysis of oxidized insulin

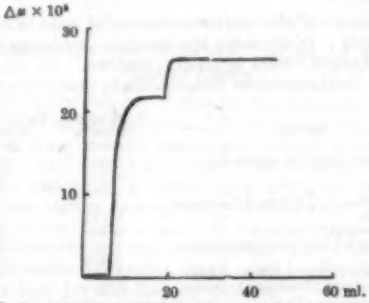

Fig. 2. Adsorption analysis of fraction *A* of oxidized insulin

product should be a relatively simple mixture of polypeptides of average molecular weight 3,000, and in order to determine its complexity it was subjected to adsorption analysis. Fig. 1 shows a typical result of a frontal analysis of a 0·2 per cent solution of the oxidized insulin by the interferometric method[1], using a filter of volume 875 π c.mm. It can be seen that the mixture consists of at least four components. Considerable differences in the relative concentrations and retention volumes on the various steps were observed in different experiments, though the general appearance was the same. The front fraction was found to contain predominantly but not entirely glycyl terminal residues[2], and little of the basic amino-acids. Fig. 2 shows a frontal analysis of the crude fraction *A*[3] on a filter of volume 250 π c.mm. Both steps had only glycyl terminal residues and no arginine or lysine, suggesting that any phenylalanyl peptides present had not been eluted from the charcoal, due to their low concentration. The retention volumes of these substances is very much affected by their concentration; thus when fraction *B* was studied three steps were formed, the first large step containing predominantly phenylalanyl terminal residues.

At this stage of the work it should not be assumed that the four steps of the frontal analysis represent the four separate peptide chains of the insulin submolecule; but it is hoped that further work will help to characterize the various components.

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[1] Tiselius, A., "Advances in Protein Chemistry", **3**, 67 (1947), with references to earlier work.
[2] Sanger, F., *Nature*, **160**, 295 (1947).
[3] Sanger, F., *Biochem. J.*, **39**, 507 (1945).

Estimation of Potassium in Composts and Sewage Sludges

It is known that the presence of silicious matter in organic substances interferes with the potash estimations. In most carbonaceous substances the silica content is small but, even so, it is often desirable to 'dehydrate' the silica, prior to the potash extraction, by the use of perchloric acid. In the cases of dried sewage sludge and composts, such as those prepared from town refuse or from sewage sludge and straw, the silicious matter forms a major portion of ash which may comprise more than 80 per cent of the dry matter. In such cases the interference of silicious matter is so serious that only 10 per cent or less of the total potash content may be extractable with hot water, after ignition, or about 20 per cent if warm dilute hydrochloric acid is used. The accompanying table shows the actual amounts of potash extracted from one gram sample of town refuse.

	Method of extraction	Mgm. K_2O
1	Extraction with hot water after ignition	0·40
2	" " warm dilute HCl after ignition	1·10
3	" " hot water before ignition	1·25
4	" " 1% citric acid before ignition	2·20
5	" " cold dilute HCl " "	2·70
6	" " conc. HNO_3 + $HClO_4$ "	3·00
7	Lawrence-Smith method before ignition	4·28
8	" " " after "	5·00

The only satisfactory method found suitable for the estimation of potash in organic substances containing large quantities of silicious matter consisted of ignition, followed by the fusion of ash by the Lawrence-Smith method and the separation of potash by any of the conventional methods.

Method 8 was the only one which gave a complete recovery of the added potassium chloride, while method 1 yielded only 20·4 per cent and method 7 92·7 per cent of the added potassium chloride.

This work was done under the auspices of the Agricultural Research Council at the University of Reading.

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Limitations of the Colony Count Test for Assessing the Total Number of Viable Bacteria in Raw and Heated Milk

During the course of an investigation on the rate of growth of *Str. lactis* in raw and heated milk, it was found that the rate of growth as estimated by the colony count test at 37° C. was very much greater in heated milk (milk heated to 70° C. for one hour), but that the reduction of methylene blue and resazurin was the same, in spite of this apparent greater metabolic activity of the organisms.

Number of viable organisms present after 4 hr. incubation at 37° C. as estimated by the colony count test

	Colony count per ml.	Methylene blue reduction time
Raw milk	5,800,000	½ hour
Heated milk	80,800,000	½ hour

In an attempt to throw some light on these anomalous results, smears were made for direct microscopical examination, and it was found that the organisms in the raw milk grew in long chains,

whereas the organisms in the heated milk grew as diplococci, or formed only very short chains.

These findings made us attempt to estimate the actual number of cocci present, by obtaining an average of the number of cells present in the long chains in the raw milk, and the short chains in the heated milk, and thus calculating the 'total microscopical count'. The results for raw and heated milk revealed the fact that the actual number of cocci present was very similar, which would account for the resazurin and methylene blue reduction times in the raw and heated milk being the same, in spite of the apparent greater number of organisms in the heated milk as estimated by the colony count test.

From these results it would appear that there may not be any growth-inhibitory factor present in raw milk for *Str. lactis*, and that the finding of Hobbs[1] of the greater number of organisms present in the heated milk was due to the organisms growing as diplococci or very short chains in the heated milk, and in consequence producing a very much greater number of colonies.

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[1] Hobbs, B. C., *J. Dairy Res.*, **10**, 49 (1939).

Angular Correlation Effects with Annihilation Radiation

If the two gamma-quanta emitted on the annihilation of a slowly moving positron-electron pair both undergo a Compton scattering, in view of the fact that they are polarized in perpendicular directions, it is reasonable to expect that the scatter distributions will be correlated in azimuthal angle. Fig. 1 shows the expected state of affairs. It has recently been proposed by R. C. Hanna to detect this effect, using counters to observe coincidences of the scattered quanta. With the view of assisting the design of the experiment, we have calculated the magnitude of the effect to be expected. We find that the differential double cross-section is given by

$$\tfrac{1}{2}r_0^4 d\Omega_1 d\Omega_2 \left[\frac{\{(1-\cos\theta_1)^2+2\}\{(1-\cos\theta_2)^2+2\}}{(2-\cos\theta_1)^2\,(2-\cos\theta_2)^2} - \frac{\sin^2\theta_1\,\sin^2\theta_2}{(2-\cos\theta_1)^2\,(2-\cos\theta_2)^2}\cos 2(\varphi_1-\varphi_2)\right]$$

where r_0 is the classical electron radius, and $d\Omega_1$, $d\Omega_2$ are elements of solid angle for quanta 1 and 2 respectively.

From this formula one sees that the expected coincidence-rate is greatest for perpendicular and least for co-planar azimuths. Assuming that both counters are placed to observe quanta scattered through the same angle ($\theta_1 = \theta_2$), the ratio of these

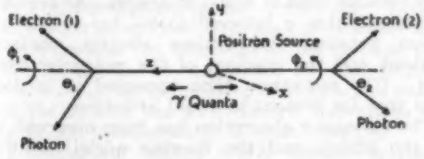

Fig. 1

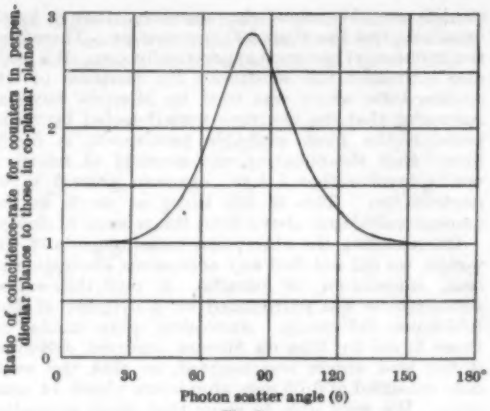

Fig. 2

coincidence-rates has been calculated and in Fig. 2 is shown plotted against the angle of scatter of the gamma-quanta. It is noticeable that a marked effect is to be expected for a scatter angle of about 90°.

A similar experiment could be performed using photo-electrons ejected by the gamma-quanta. If both electrons are ejected from the K-shell (or any s-state), it may be shown that the dependence of their angular distribution on azimuth is proportional to $\sin^2(\varphi_1 - \varphi_2)$, which again is greatest for perpendicular azimuths and is actually zero for co-planar azimuths. If, however, one or both the electrons are ejected from states of higher angular momentum, the correlation is much reduced. It is commonly estimated[1] that some 80 per cent of the photo-electrons are ejected from the K-shell; some 65 per cent of coincidences will therefore correspond to both electrons originating in the K-shell. One may therefore expect a marked correlation in azimuth for photo-electrons also.

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[1] Heitler, "Quantum Theory of Radiation", 127 (Oxford, 1936).

Evidence Against Spontaneous Emission of Neutrons by Uranium X

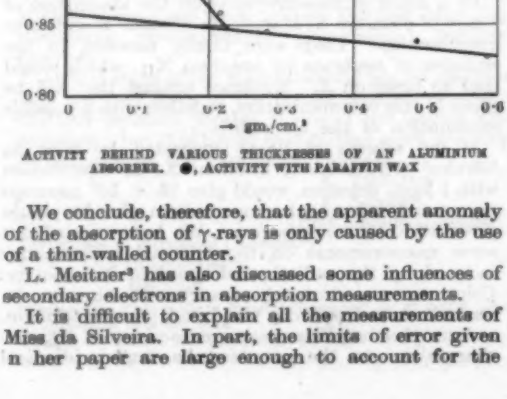
In a series of measurements on the absorption of γ-rays of uranium X, Marieta da Silveira[1] found some irregularities. They were finally ascribed to the emission of neutrons by uranium X_{II}, which would lead to uranium Z. Evidence against this will be given in this communication, together with a possible explanation of the anomalies.

If the scheme of decay suggested by Miss da Silveira[1] were correct, uranium X, in equilibrium with 1 kgm. uranium, would give 26×10^3 neutrons per second, whereas 1 mgm. radium plus beryllium gives 20×10^3 neutrons/sec. We have carried out some measurements on the artificial radioactivity induced by the radiation of uranium X in silver. Using an experimental arrangement already described[2], no radioactivity was found, whereas 90 mgm. radium plus beryllium causes an activity of 200 discharges/sec. in the counter-tube, under identical

conditions. We conclude, therefore, that 1 kgm. uranium gives less than 250 neutrons/sec. Therefore, the emission of neutrons is practically zero. We have also estimated the sensitivity for neutrons of the counter-tube which was used by Miss da Silveira. Assuming that the neutrons were detected by recoil protons—the most probable process—it is easily found that the counting-rate ascribed to neutrons would involve that 1 kgm. uranium gives 6×10^6 neutrons/sec. This is 250 times as much as the amount calculated above from the scheme of decay.

On repeating the absorption measurements of the γ-rays, we did not find any anomalous absorption in lead, aluminium or paraffin, if our thin-walled counter-tube was surrounded by a cylinder of lead (thickness 0·5 mm.). Anomalies quite similar to those found by Miss da Silveira occurred, however, if the lead screen was omitted, so that the walls only consisted of 0·05 mm. aluminium plus 0·14 mm. glass. We were able to show that these anomalies were caused by the fact that behind a lead absorber the number of secondary β-rays is larger than behind light elements. The counting-rate of a thin-walled counter-tube depends on the number of Compton electrons originating from the last layer of the absorber, which has a thickness equal to the range of the Compton electrons (0·24 gm./cm.² in our case). In the accompanying figure the counting-rate behind aluminium and paraffin absorbers is shown. The arrangement was as follows: uranium X (2 kgm. equivalent), contained in a lead cylinder (thickness 3 mm.), 2 cm. free space, lead screen (0·5 mm.), absorbers, 2 cm. free space, counter-tube. The apparent 'anomalous' strong absorption shows itself. It corresponds, however, to the absorption of the Compton electrons of lead; the range (0·23 gm./cm.² plus 0·3 gm./cm.² for the counter-tube) is in close agreement with the value given above. Zinc absorbers gave the same results.

If the lead and paraffin absorbers are interchanged the activity increases from 70 ± 1 to $85 \pm 1·5$. This demonstrates once more that the number of secondary electrons is greater behind lead than behind light elements.



ACTIVITY BEHIND VARIOUS THICKNESSES OF AN ALUMINIUM ABSORBER. ●, ACTIVITY WITH PARAFFIN WAX

We conclude, therefore, that the apparent anomaly of the absorption of γ-rays is only caused by the use of a thin-walled counter.

L. Meitner[3] has also discussed some influences of secondary electrons in absorption measurements.

It is difficult to explain all the measurements of Miss da Silveira. In part, the limits of error given in her paper are large enough to account for the differences between her measurements and ours. Other differences may be caused by the conditions of the experimental arrangement, because the number of Compton electrons which are counted behind an absorber strongly depends on the relative position of the absorber, the source and the counter-tube; this follows from simple geometrical considerations, and it was checked by experiment. As an example, the activity decreased from 88 to 72 if a lead screen (0·5 mm.) was set close to the counter-tube instead of close to the small lead cylinder which contained the source.

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[1] da Silveira, M., *Portugaliæ Physica*, **1**, 167 (1945).
[2] Groendijk, H., and de Vries, Hl., *Physica*, **10**, 281 (1943).
[3] *Arch. f. Math. Ast. o. Phys.*, **29**, No. 17 (1943).

Nuclear Magnetic Resonance at Low Temperatures

MEASUREMENTS on nuclear magnetic resonance at a frequency of 2 Mc./sec. in liquid and solid hydrogen and in alkali halides at liquid hydrogen temperatures, which were reported in a recent communication[1], have now been extended to the liquid-helium temperature region.

In solid hydrogen there was found to be a considerable increase in the resonance width with decrease of temperature. The broadening begins at a temperature of about 11·5° K., and is probably associated with the increase in order of the molecular orientation which begins at this temperature, as shown by the anomaly in the specific heat[2]. A decrease in the rate of fluctuation of the local magnetic field due to molecular rotation would be expected to give rise to an increase in the width of the resonance[3]. On lowering the temperature, the resonance signal at first decreased on account of the increasing line width, but at 4° K. it was increasing again due to the increase of the Boltzmann factor. This increase continued until a temperature of about 1·5° K. was reached, after which the signal decreased rapidly as the temperature was reduced, and below 1·3° K. was unobservable. The variation of signal with temperature over this range may be a consequence of the increasing Boltzmann factor competing with the effects of the ordering, due to the three-fold splitting of the nine-fold degeneracy of ortho-hydrogen, which sets in at 11·5° K. and is probably complete between 1° K. and 1·5° K.[3]. However, the possibility that the rapid decrease of signal at 1·5° K. is due to a further splitting cannot be excluded entirely, though it would appear unlikely at this temperature.

Preliminary measurements have been made on liquid deuterium (90 per cent D_2), and it was found that, at the boiling point, the resonance is considerably broader than in liquid hydrogen. As previously suggested[4], this is believed to be due to the interaction between the nuclear electric quadrupole moment and the gradient of the molecular electric field. The relaxation time appeared to be longer than that for protons in liquid hydrogen.

The resonance absorption has been observed both for the lithium and the fluorine nuclei in lithium fluoride at temperatures down to 1° K. There

appears to be no appreciable change in either the line widths or relaxation times over the temperature-range investigated. For lithium the width is of the order of 10 gauss and the relaxation time 5 sec. It is interesting that, in an ionic crystal in which there is no molecular rotation, the exchange of energy between the nuclei and the lattice is still rapid even at these temperatures.

The lithium resonance has been detected in lithium chloride at liquid helium temperatures. The relaxation-time is considerably longer than in the fluoride and is estimated to be about 2 min. at 2° K.

Some further measurements of proton resonance have been made by the method of nuclear induction[5,6] at a frequency of 8 Mc./sec. At 20° K. the relaxation time in liquid hydrogen is between 0·2 and 0·5 sec., in paraffin wax it is about 0·1 sec. (0·01 sec. at room temperature), and in crystalline iron alum it is less than 0·001 sec. (the limit of measurement of our present apparatus). In iron alum the line breadth at 20° K. is considerably greater than at room temperature.

The results obtained with lithium fluoride suggest that, if there is no considerable change of line width or relaxation time with further reduction of temperature, the measurement of nuclear resonance absorption in this substance may serve as a method for measuring absolute temperature in the region below 1° K. It is also probable that lithium fluoride could be used for obtaining very low temperatures by the method of adiabatic nuclear demagnetization[7,8,9]. We hope soon to make further experiments to investigate these possibilities.

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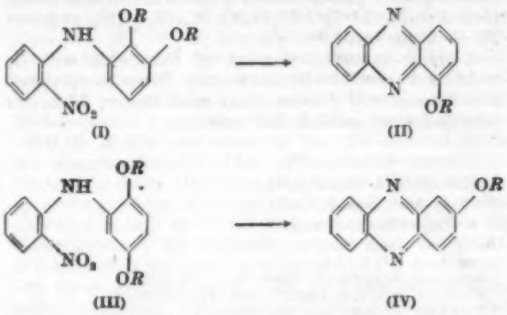
[1] Rollin, B. V., and Hatton, J., *Nature*, **159**, 201 (1947).
[2] Simon, F., Mendelssohn, K., and Ruhemann, M., *Naturwissen.*, **18**, 34 (1930); also *Z. phys. Chem.*, B, **15**, 121 (1931).
[3] Bloembergen, N., Pound, R. V., and Purcell, E. N., *Phys. Rev.*, **71**, 466 (1947); also *Nature*, in the press.
[4] Rollin, B. V., *Nature*, **158**, 669 (1946).
[5] Bloch, F., *Phys. Rev.*, **70**, 460 (1946).
[6] Bloch, F., Hansen, W. W., and Packard, M., *Phys. Rev.*, **70**, 474 (1946).
[7] Gorter, C. J., see Debye, P., *Phys. Z.*, **35**, 923 (1934).
[8] Kurti, N., and Simon, F., *Proc. Roy. Soc.*, A, **149**, 152 (1935).
[9] Simon, F., Conference on Magnetism, Strasbourg, **3**, 1 (May 1939).

Phenazines and Benzcinnolines

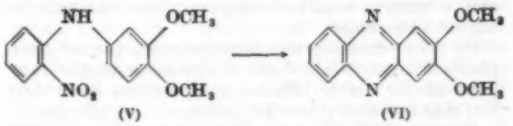
A number of attempts have been made to devise general methods for the synthesis of phenazines[1,2,3]; but in a series of researches carried out during 1945–46 we found that most of the well-known methods failed in the case of some di-alkoxyphenazines. On the other hand, comparatively good results were obtained using the little-known reaction of Waterman and Vivian[4], which depends on the treatment of a 2-nitro- or 2 : 2′-dinitrodiphenylamine with an 'oxygen acceptor' such as reduced iron, lead or charcoal at a high temperature. In simple cases the reaction presumably proceeds, as suggested by the original authors, through the elimination of oxygen and water, but in the case of the 2 : 2′-dinitro derivatives the course of the condensation is more obscure.

One interesting feature which became apparent during this series of experiments is that the preferential elimination of an alkoxy group rather than a hydrogen atom will occur when both are available for condensation as, for example, in (I) or (III).



In the above cases, where $R = CH_3$, the known[5,6] 1-methoxy and 2-methoxyphenazines (II and IV) were obtained exclusively, chromatographic analysis from ligroin yielding no trace of the expected dimethoxy derivatives. Similarly, 2-nitro-2′-methoxydiphenylamine gave the parent phenazine. This behaviour recalls that of 2-amino-2′-methoxydiphenylamine, which also gave phenazine on treatment with litharge[5], but it is difficult to see that prior reduction can occur under the conditions cited above.

With 2-nitro-3′ : 4′-dimethoxydiphenylamine (V), where the 2-position is free, condensation proceeded normally to give 2 : 3-dimethoxyphenazine (VI) which, on demethylation and acetylation, gave a diacetate identical with that already described[6]; no sign of the isomeric 1 : 2-dimethoxy derivative was found.



Despite the rather unexpected features of this reaction, 1 : 2- and 1 : 4-dialkoxyphenazines were easily obtained by the simple expedient of using an appropriate diphenylamine carrying all substituents in the same ring. Thus, with reduced iron at 250°, 2-nitro-5 : 6-dimethoxydiphenylamine, m.p. 68–69° (found : N, 10·1. $C_{14}H_{14}O_4N_2$ requires N, 10·2 per cent), was converted to 1 : 2-dimethoxyphenazine crystallizing from ligroin in orange-yellow blades, m.p. 138–139° (found : N, 11·5. $C_{14}H_{10}O_2N_2$ requires N, 11·7 per cent). In this case, reaction proceeded most smoothly when an inert diluent, for example, liquid paraffin, was used. Similarly, 2-nitro-3 : 6-dimethoxydiphenylamine, m.p. 126–127° (found : N, 10·25. $C_{14}H_{14}O_4N_2$ requires N, 10·2 per cent), was converted to 1 : 4-dimethoxyphenazine, obtained from ligroin in orange, hair-like needles, m.p. 185° (found : N, 11·9. $C_{14}H_{10}O_2N_2$ requires N, 11·7 per cent).

It was shown by Waterman and Vivian[4] that this reaction could be used, *mutatis mutandis*, as a route to various heteropolycyclic nuclei other than phenazine, examples being oxazines, carbazoles and benziminazoles. We have found that it also provides a new process for the synthesis of benzcinnolines. For example, 2 : 2′-dinitrodiphenyl, treated with reduced iron under the conditions described, gave 3 : 4-benzcinnoline, m.p. 241–243°, identical with the com-

pound already described in the literature[7]. Identification was confirmed by conversion to the dipicrate, m.p. 192° (decomp.), which crystallized from alcohol in orange-red plates with a pronounced green reflex (found: N, 17·7. $C_{12}H_8N_2$, $C_{12}H_8O_{14}N_8$ requires N, 17·6 per cent).

A much-extended account of this work will be published elsewhere in due course. We wish to thank the directors of Messrs. May and Baker, Ltd., for permission to publish this note.

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[1] Clemo and McIlwain, *J. Chem. Soc.*, 1991 (1934).
[2] Wrede and Strack, *Z. physiol. Chem.*, **177**, 177 (1928).
[3] Tomlinson, *J. Chem. Soc.*, 158 (1939).
[4] Waterman and Vivian, U.S. Patent 2,292,808.
[5] McCombie, Scarborough and Waters, *J. Chem. Soc.*, 353 (1928).
[6] Fischer and Hepp, *Ber.*, **23**, 8141 (1890).
[7] Ullmann and Dieterle, *Ber.*, **37**, 24 (1904).

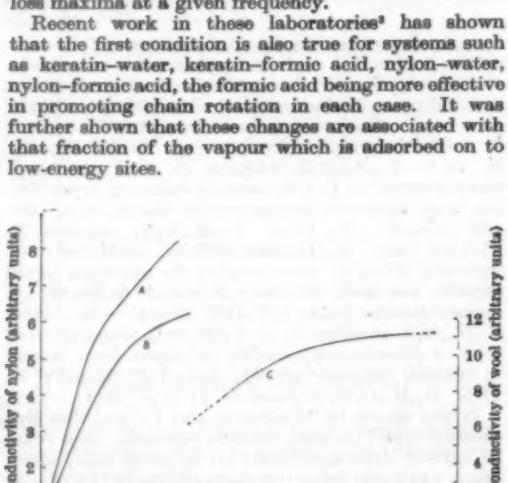
Effect of Polar Vapours on the Direct-Current Conductance of Keratin and Nylon

Fuoss[1,2] and others have shown that in polar polymer-plasticizer systems there exists some correlation between the frequency of the maximum power-loss absorption, and (*a*) the elastic moduli, and (*b*) the conductance. That is:

(*a*) A decrease in Young's modulus, due to either an increase in plasticizer content or an increase in temperature, is associated with increased freedom of rotation of the polar groups in the polymer chains and in general a shift of the power-loss maximum to higher frequencies.

(*b*) The direct-current conductance for a given plasticizer-polymer system is the same at the temperature for which different compositions have their loss maxima at a given frequency.

Recent work in these laboratories[3] has shown that the first condition is also true for systems such as keratin–water, keratin–formic acid, nylon–water, nylon–formic acid, the formic acid being more effective in promoting chain rotation in each case. It was further shown that these changes are associated with that fraction of the vapour which is adsorbed on to low-energy sites.



A, Nylon–formic acid; *B*, nylon–water; *C*, wool–water

This work has now been extended to investigate the second relation by measurements on the direct-current conductivity of nylon–water and nylon–formic acid systems, and the results are shown in the accompanying graph. It is seen that in accordance with (*b*) the formic acid is more effective in promoting increased conductivity. Furthermore, in both cases the rate of increase in conductivity falls away at an absorbate concentration of about 0·3 mols per 100 gm. A similar turning point has been obtained for the corresponding elastic modulus relations, when it was shown that this corresponds to the saturation of the available low energy sites.

In the case of the wool–water system a similar bend in the conductivity relation was observed by Marsh and Earp[4], who also suggested a connexion with the corresponding elastic modulus relation. Their results are plotted in the graph, and it is seen that the bend occurs in this case for a molar sorption of about 1·0 mols per 100 gm., which, according to Cassie, corresponds to saturation of the low-energy sites.

Fuoss[5] suggests that the conductivity in such systems is ionic, the plasticizer facilitating the diffusion of ionizable impurities originally present in the polymer. Such a theory would account for the results obtained with nylon and keratin.

An alternative theory due to Baxter[6] suggests that the adsorbed molecules act as impurity centres for electronic conduction. In such an event the above results suggest that these impurity centres are to be associated with occupied low-energy sites.

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[1] Fuoss, *J. Amer. Chem. Soc.*, **63**, 378 (1941).
[2] Davies, Miller and Busse, *ibid.*, **63**, 361 (1941).
[3] King, *J. Colloid Sci.* (in the press).
[4] Marsh and Earp, *Trans. Farad. Soc.*, **29**, 173 (1933).
[5] Fuoss, *J. Amer. Chem. Soc.*, **61**, 2329 (1939).
[6] Baxter, *Trans. Farad. Soc.*, **39**, 207 (1943).

Spread of Detonation in High Explosives

In a note[1] on the spread of detonation in a mass of high explosive from the point of initiation, Weibull demonstrates that, in a cylindrical cartridge of compressed T.N.T., detonation is propagated with a uniform and constant speed in all directions from the detonator. It may be of interest to record that pressed T.N.T. is not unique in this respect and that other high explosives, under suitable conditions, behave in a like manner. Nevertheless, as has already been shown[2], a constant rate of detonation from the point of initiation is not a feature common to all high explosives. This is further illustrated in Fig. 1, which is a conventional photograph of detonation traversing a 1¼ in. diameter cartridge of granular T.N.T. cartridged at a density of 1·0 gm./c.c. The cartridge was 7 in. long and was initiated with a detonator embedded in the explosive at the end corresponding to the hooked end of the trace. The curvature of the trace shows that the velocity of detonation was still increasing at 4 in. from the end of the detonator. It is interesting to note that this is the same explosive as that used by Weibull, but in a different physical condition, so that the con-

stancy or otherwise of the rate of detonation in the initial stages is not a function of the explosive alone, but also of its physical condition.

It should also be mentioned that, whether the velocity of detonation is initially constant or not, the detonation wave, in general, tends towards the spherical shape; and any perturbations introduced initially due to the size and shape of the detonator tend to disappear, and that very rapidly. This is illustrated in Fig. 2, which shows an end-on photograph of the kind reproduced by Weibull. The explosive in this case was liquid nitroglycerine which, being transparent, permits the camera to register the progress of detonation inside the cartridge as well as on the surface[2]. The apex of the figure represents the point of initiation, and the sloping sides indicate the lateral spread of detonation to either side of the detonator. A detailed analysis of this and the corresponding 'side-on' photograph of the liquid nitroglycerine cartridge showed that the initial velocity of detonation normal to the axis of the detonator was appreciably less than that along the axis, but that rapid acceleration in the first $\frac{1}{4}$ in. resulted in the spherical form being established; thereafter, the spread of detonation appeared to be uniform in all directions in nitroglycerine initiated at the high velocity of detonation, that is, approximately 8,000 metres/sec.

Assuming that detonation expands spherically at a constant speed, it can be shown that the photographic record of the detonation wave breaking through the surface of a cylindrical cartridge initiated on the axis is a hyperbola, whether the photographs be taken in the side-on or end-on positions. The hyperbola is represented by

$$\left(\frac{D}{v}y + R\right)^2 - \left(\frac{x}{m}\right)^2 = R^2,$$

where D is the detonation velocity of the explosive, v the speed of the photographic film and m the magnification of the lens system. With side-on photographs, R is the radius of the cartridge less that of the detonator, but with end-on photographs R is the distance of the end from the point of initiation.

Typical records obtained in the two positions are shown in Figs. 3 and 4, the former a side-on photograph of a 3-in. diameter cartridge and the latter an end-on view of a similar cartridge. The explosive used to obtain the photographs reproduced was Polar Dynobel No. 2, a nitroglycerine powder of the 'permitted' type used in coal-mining. Detailed analysis of such photographs confirms the hyperbolic form of the curves in cases where the velocity of detonation is uniform, and in these cases the value of R in the above equation can be derived from actual measurement of the photographic traces. In the end-on shots, the value of R, as already indicated, gives the position of the point of initiation, and results obtained in this way lead to the same conclusion as that expressed by Weibull, namely, that the point of initiation is not usually at the end of the detonator, but some distance back. In his experiments, this point coincided with the interface between the priming and base charges of the detonator; but we believe that the point of initiation varies in position, depending on the strength of the detonator and the sensitiveness of the explosive. This view seems reasonable because, if the detonator gives a point of maximum initiating power at its end and the explosive is only just sensitive enough to be initiated by this maximum value, the point of initiation may be expected to coincide with the end of the detonator.

One further point which deserves mention is that the progress of detonation along both axis and surface of a transparent cartridge may be followed from a single 'side-on' photograph provided an assessment can be made of the time-interval during which luminosity persists at any given point on the axis. Comparison of 'side-on' and 'end-on' records permits an upper estimate of this interval to be made. Thus, the vertical height of the arch in Fig. 2 represents the time between extinction of light on the axis and at the periphery of the terminal section. The difference between this height and the time-breadth of the corresponding part of the 'side-on' record should therefore provide a measure of the duration of luminosity on the axis. It was concluded that, for nitroglycerine at high velocity, this does not exceed 0·3 μsec.

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[1] Weibull, *Nature*, **159**, 402 (1947).
[2] Jones, *Proc. Roy. Soc.*, A, **120**, 603 (1928).

A Short-lived Solar Phenomenon in High Latitude

ON the morning of June 19, 1947, at 09h. 46m. U.T., while scanning the solar disk with the spectrohelioscope of the Solar Physics Observatory, Cambridge, in $H\alpha$ light, my attention was suddenly attracted by an intensely dark absorption flocculus near the south point of the sun. The region had three nuclei of the order of 1′ of arc in diameter or less, more jet black in appearance than any flocculi I have previously observed. There was only just time to confirm the reality of the phenomenon and obtain a preliminary measure of its position before clouds intervened at 09h. 48½m. No sign of the flocculus could be observed at first when the clouds

cleared, but at 09h. 57m. one nucleus (*A*) was picked up at a line-shifter reading corresponding to a velocity of recession of 74 km./sec. Later, the other nuclei, *B*,*B*′, were picked up at a still higher velocity as a single marking much fainter in contrast. The complete set of readings in the observing book, together with the corresponding velocities, are given below:

Time	Region	Line-shifter reading	Radial velocity (km./sec.)
09h. 46m. (clouds)	*A*,*B*,*B*′	—	—
09h. 57m.	*A*	+ 19	+ 74
10 04	*B*,*B*′	+ 42	+ 144
10 05	*A*	+ 31	+ 109
10 06	*B*,*B*′ (faint)	+ 50	+ 171
10 07½	*A*	+ 36	+ 124

The heliographic co-ordinates of the centre of the flocculer area were found to be 6° W., 61° S. (kindly computed by Mr. E. T. Pierce from two of my measured positions). The high latitude—well outside the sunspot zone—of the phenomenon renders it of peculiar interest.

If one is correct in attributing the line-shifts to sight-line velocities, the three observations of *A* define a linear acceleration of recession of $0{\cdot}81 \times 10^4$ cm./sec.^{2}, that is, about 30 per cent of solar gravity at the sun's surface. No line-shifter reading is available for the first observation, but the radial velocity could not have been far from zero at 09h. 46m., and this is quite consistent with a linear extrapolation of the velocity-time plot. Observations of the nuclei *B*,*B*′ cannot define the acceleration so exactly, but the value seems to lie between 45 and 80 per cent of solar gravity. These figures are of the same order of magnitude as those found by other observers for dark flocculi in regions surrounding sunspots and flares[1]. It is possible that here we are dealing with a similar phenomenon in a region entirely free from sunspots and from flare activity.

Consultation with the Cavendish Field Laboratory (results are quoted by permission of Mr. M. Ryle) reveals the interesting fact that although June 19 was marked by an absence of fade-outs, there was an increase in radio-noise on 175 Mc./sec. of some two to three times the normal 'undisturbed' mean value, and that there was special activity, including bursts up to five times the average value between 10h. 03m. and 10h. 10m. with a maximum at 10h. 08m. (± 2 min.). It is further understood that while such bursts have not been very uncommon, only about six per month have recently been recorded of comparable intensity.

There can be little doubt that at the time of these radio disturbances this short-lived *Hα* flocculus was the only noteworthy phenomenon visible in the spectrohelioscope. A bright flocculus at 31° W., 21° S. had been noted at 09h. 11m. and later of undiminished intensity, but scarcely bright enough to be classed as a weak flare. A few prominences of no great intensity were also observed at the limb.

If the two phenomena are connected, and again if the line-shifts are due to recessional velocities, it appears that we have to deal with a mass of gas moving into the sun in high latitude through a distance, in the line of sight, of some 6×10^4–10^5 km. before it disappeared while moving with a velocity of more than 120 km./sec.; and secondly, that the radio-noise is to be associated with the later stages of the trajectory. It may be that the gas in question was originally ejected from the sun and that earlier observations would have revealed a velocity of approach. But such an ejection must have taken place at or before 09h. 46m., that is, 17 minutes before the radio-burst (the same time-lag holds for both phenomena). Thus the source of the noise seems to be connected in this case with an entry of matter into the sun rather than an ejection.

The connexion between the two phenomena cannot, of course, be regarded as established by this isolated case, but the solar observation suffices to emphasize (*a*) the need for spectrohelioscope observers to watch all zones of the sun, irrespective of the presence of sunspots, and (*b*) the ease with which short-lived solar phenomena may be missed if only the zero position of the line-shifter is used.

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Aug. 5.

[1] Newton, H. W., *Mon. Not. Roy. Ast. Soc.*, **102**, 2 (1942). Ellison, M. A., *Mon. Not. Roy. Ast. Soc.*, **102**, 11 (1942).

Flow of Smoke through a Hole in a Resonant Cavity

F. W. Simpson[1] has described an experiment in which a resonant tube with a small hole in its end is excited in an outer atmosphere of smoke, and points out that smoke can be seen streaming in through the hole. This is the reverse of the effect originally noted by Prof. West[2], and was described by Lawson[3]. When West's experiment is performed with a glass tube, smoke can be observed streaming out and fresh air streaming in, apparently continuously.

With a tube closed at one end and of length three-quarters of a wave-length, Simpson has also shown that, when it is filled with smoke and has a small hole at each of the pressure antinodes and at the pressure node, smoke streams out at the antinodes but not at the node during excitation. He has also observed the reverse effect when the smoke is outside the tube. The former experiment is really a simple adaptation of the Rubens tube[4], which provides an excellent lecture experiment for demonstrating the pressure conditions in a resonating tube. In the form shown in this Department for many years, it consists of a long thin-walled brass tube about 2½ in. in diameter, closed at one end and excited at the other by an attached loud-speaker element, operated by an acoustic oscillator of variable frequency. The upper surface of the tube is pierced along its length by a large number of small holes, regularly spaced. When the tube is fed with coal gas at suitable pressure through a side tube and the jets are ignited, they burn uniformly to a height of, say, ½ in. in the quiescent state. On exciting the tube at any resonant frequency, the jets of flame vibrate and increase in length sinusoidally from the pressure nodes to reach their maximum length at the pressure antinodes. The jets are bluer than ordinary gas jets of comparable size, which suggests a local admixture of air with the burning coal gas, as might be expected to occur during the rarefactional phases of the vibration[3].

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July 23.

[1] *Nature*, **160**, 93 (1947).
[2] *Nature*, **159**, 755 (1946).
[3] *Nature*, **159**, 166 (1947).
[4] Grimsehl's "Lehrbuch der Physik", **1**, 721–2, 6th edit. (Teubner, 1923).

PHYSICAL METHODS OF GAS ANALYSIS

THE Physical Methods Group of the Society of Public Analysts and Other Analytical Chemists devoted a meeting held on May 2, at King's College, Newcastle-upon-Tyne, to a consideration of some applications of physical methods to the analysis of gases. Under the chairmanship of Mr. R. C. Chirnside, three short papers which dealt with widely differing aspects of the subject were read and discussed.

The first paper, by Dr. C. E. Ransley, on "Gas Analysis at Low Pressures", gave a brief review of the development of micro-gas analysis by this technique and described a new simplified procedure for the analysis of mixtures containing carbon monoxide, carbon dioxide, hydrogen, nitrogen and methane. He said that the feasibility of a relatively simple procedure for the analysis of very small volumes of gas at low pressures (namely, less than 0·1 mm. of mercury) was first demonstrated so early as 1912 by Langmuir, in his classical work on gas reactions at solid surfaces. The number of papers published on applications of the method is not large, however, and nearly all have originated from the United States. Comparatively few workers in Great Britain appear to make use of this quite valuable research tool, possibly because the requisite facilities for the somewhat specialized high-vacuum work are not generally available. It is possible to analyse so little as 0·001 ml. of gas by this method, and the type of apparatus used makes it particularly suitable for examination of the gases evolved from heated metals, glasses, ceramics and so on.

In developing a procedure for micro-analysis at low pressures it is possible to make use of some chemical reagents in a fairly orthodox manner. For example, in the method described by Prescott and Morrison[1], reagents such as magnesium perchlorate and soda-lime were used in the form of small plugs containing only a fraction of a gram of powder, through which the gases were circulated by means of automatic Toepler or miniature diffusion pumps. There are objections, however, to the use of powdered reagents in vacuum systems, and it is preferable to make the maximum possible use of physical methods; several advantages accrue, not the least of which is the fact that repeated measurements then become possible. In the procedure described, condensable gases are determined by means of the vapour pressure–temperature curve technique originated by Campbell[2]; or when water vapour and carbon dioxide are the only condensable gases present, these are readily measured by freezing out with freezing acetone or liquid air. Further, the specific diffusion of hydrogen through palladium provides a very useful method for the determination of this gas, and by arranging the apparatus so that the diffused hydrogen is collected for separate measurement, the accuracy can be considerably enhanced. Carbon monoxide and methane are determined by differential oxidation on neutral filaments, and the oxygen for this purpose is introduced into the system by diffusion through a heated silver tube. The carbon monoxide is oxidized at a platinum filament at 500° C., and the methane at a platinum filament coated with alumina which is heated to 1,000°–1,100° C. The oxidation products are condensed into separate traps cooled with liquid air, and can be determined afterwards if necessary.

The discussion on this paper was mainly concerned with the separation of condensable gases by the Campbell method of microdistillation using the Pirani gauge. Dr. Ransley stated that if the condensation temperatures of the constituent gases are sufficiently widely separated, so that on warming the condensate the first gas attains its full partial pressure before the temperature rises to the condensation temperature of the second, and so on, a practical separation can readily be made.

The quantitative analysis of the natural and refinery gases of the type encountered in the petroleum industry is not an easy matter, since a sample may consist of anything from a simple binary mixture to a complex paraffin–olefin mixture containing up to a dozen or more constituents. Fortunately, the lighter hydrocarbons, containing one to five carbon atoms, have a comparatively wide boiling range (nearly 200° C.), and the separation and analysis of these complex mixtures by fractional distillation at low temperatures was indicated as a feasible method of approach. Several types of apparatus for this purpose have been described in the literature, and some are available commercially; considerable contributions have been made in this field by Podbielniak[3]. Mr. J. H. D. Hooper, in the second paper given at the meeting ("The Analysis of Hydrocarbon Gases by Low Temperature Distillation"), gave an account of the development of the specialized apparatus used for this type of analysis, and indicated some of the practical difficulties which had to be overcome. The most recent advances have been in connexion with the design of the distillation column and condenser, and in the greater application of automatic devices to render the operator's task a little less arduous. Many forms of packing for the distillation column have been suggested; most of them are equivalent to 7–15 theoretical plates, but the new 'Heli-Grid' construction[3] is reputed to be equivalent to about fifty equivalent plates. Mr. Hooper finds that by using this packing it is possible to separate such close-boiling components as iso-butane (−11·8° C.) and iso-butene (−6·8). The normal procedure in making an analysis is to separate the sample into fractions containing one, two, three, four and five carbon atoms per molecule. These fractions are then examined on subsidiary apparatus, or in special cases by different techniques such as absorption, combustion or spectroscopic methods.

So far as automatic devices are concerned, the most useful advances have been in the provision of automatic control of column pressure. It is possible now to obtain apparatus which plots the complete distillation curve of a sample, and such apparatus, although necessarily rather complicated and expensive, is capable of yielding more accurate results than can be obtained by manual control.

In reply to a question asked in the subsequent discussion, Mr. Hooper said that gas collection using pressure measurement is generally to be preferred to collection using volume measurement, because the manipulation is simpler. He also stated that sufficiently clear-cut fractionation of the C_2 and C_3 components can be made to enable the fractions to be examined by infra-red spectroscopy, without the strong ethylene band at 12μ obscuring the C_2 spectrum.

The final paper, entitled "A New Apparatus for Gas Analysis by the Soap Film Method", was given by Mr. W. J. Gooderham. He also demonstrated the first commercial unit produced in accordance with

his principles, an impressive piece of apparatus which aroused considerable interest. His procedure is perhaps only admissible as a 'physical method' by virtue of the fact that the extensive chemistry involved in the analysis is very unobtrusively and automatically performed. In introducing his paper, Mr. Gooderham said that given a series of accurate gas meters which do not appreciably absorb gas or cause loss of pressure, the simplest form of gas analysis can be obtained by passing gas through a meter, a reagent which removes one constituent completely, another meter, another reagent and so on. The soap-film meter, which he has described in earlier papers[4], is ideal for this purpose. The apparatus demonstrated was arranged for the analysis of coal gas; this operation only took a minute or so to carry out, and the percentage analysis of a sample could be read directly from the meters. This was done by allowing the initial intake meter to move up 100 divisions, and then noting the change in each of the other meters, which represented the gas volume after successive constituents had been removed. Conventional reagents were used for absorption; but it was necessary to design the absorption pipettes so that only a very small back-pressure was developed.

Since the method is a dynamic one, a certain minimum passage of gas through the apparatus is necessary before reproducible final analyses were obtained. Several speakers in the discussion referred to this point, and Mr. Gooderham said that 1–1½ litres of gas is usually sufficient to complete a full analysis with several repeats, and the sweeping-out operation, which normally took half an hour or so, could be speeded up if required. He also stated, in reply to other questions, that the accuracy of the apparatus is 0·2 per cent on each constituent, but that it might be possible to design for a greater sensitivity than this. Apparatus for the determination of carbon dioxide, oxygen and carbon monoxide in waste gases has also been made and used. It is preferable to use a special acidic soap solution for the meters.

The meeting was a pleasant and profitable one. It is expected that the papers which were read will shortly be reproduced in full in *The Analyst*.

[1] Prescott, C. H., and Morrison, J., *Indust. Eng. Chem.* (*Anal. Ed.*), **11**, 230 (1939).
[2] Campbell, N. R., *Proc. Phys. Soc.*, **33**, 287 (1921).
[3] Podbielniak, W. J., *Indust. Eng. Chem.* (*Anal. Ed.*), **3**, 177 (1931); **5**, (1933) 119; **5**, 172 (1933); **13**, 639 (1941).
[4] Gooderham, W. J., *J. Soc. Chem. Ind.*, **59**, 1 (1940); **63**, 351 (1944).

CONGRESS OF THE INTERNATIONAL ASSOCIATION FOR THE PROTECTION OF INDUSTRIAL PROPERTY

THE Congress of the International Association for the Protection of Industrial Property (sometimes affectionately termed 'Pip') was held recently at The Hague at the invitation of the Netherlands Group of the Association. This Congress had been originally fixed for 1940.

The Association is an informal body of industrialists, patent agents, barristers and solicitors who are directly interested in questions relating to inventions, designs, trade marks and copyright. The expression 'industrial property' is a convenient portmanteau phrase for describing commercial rights connected with international trade and industry. It was largely as a result of the endeavours of the Association that the International Convention of 1883 was signed by the representatives of forty countries. The Convention agreement is not binding upon the domestic legislation of the countries adhering to it. It is, in effect, a code of conduct to facilitate international trade, and one of its main objects is to prevent all kinds of unfair trading.

The Association maintains a constant watch over international relationships in these matters, and the Congress at The Hague was an outstanding example of its activities. There were about four hundred delegates from most of the countries of the world except the U.S.S.R., Germany and Japan. The British group comprised about fifty delegates including seven counsel, and the British point of view was expressed with commendable clarity.

On the opening day of the Congress the president of the British Group, Mr. Lionel F. Heald, K.C., submitted a proposal that any question relating to the interpretation of the language of the International Convention should be referred to the International Court of Justice at The Hague. After a lively and well-informed discussion in which the great majority of the countries represented took part, the president of the Association (Senator Marcel Plaisant of France) was able to announce that the proposition had been carried unanimously.

Another interesting matter which caused much discussion concerned the translation of trade marks from one language to another. When goods have been sold under a 'trade name' which is a word in the vernacular of one of the countries, it may happen that a trader in another country may attempt to market similar goods in that foreign country under the name which is a translation of this word. The British delegation urged that if goods were registered abroad under a word in the language of origin of the goods, then that registration should cover the translation of the word in the vernacular of the foreign country. Although this view was not accepted by the Conference as a whole, it was unanimously agreed that a word and its translations in other countries could be registered at one and the same time, and that this step would be helpful in avoiding unfair trading.

By the Convention of 1883, an International Office of the Association was established at Berne and was placed under the authority of the Swiss Government. This Office centralizes information of every kind relating to the protection of industrial property, and publishes it. To facilitate this important work, it was resolved that countries adhering to the Convention should communicate to the Berne office all acts and statutory rules and orders relating to industrial property arising in the course of their domestic legislation. If any country failed to carry out the reciprocal commitments contained in the Convention, it was felt that the International Office at Berne should have powers to bring this fact to the attention of the Government of the country in question. The International Association should be given powers to formulate officially any opinion which it might be asked to give by the Government of any adherent country concerning its interpretation of the Convention.

One resolution concerned a modification of the procedure for priority rights in other countries in respect of an application for a patent or for the registration of a utility model, industrial design or trade mark in one of the Convention countries.

Two other resolutions concerned the international registration of trade marks. Another resolution provided that the validity of a 'patent of addition' should not necessarily be affected should the substantive patent be declared invalid or be revoked. In the light of the increase in modern scientific research, whether sponsored by Governments, by universities, or by firms, it is increasingly desirable that its practical or industrial applications should not only be carefully studied from a national aspect but also from an international aspect. The representatives at this Congress appreciated that if international trade is to be increased it is essential that harmony should be achieved between the laws of different countries relating to industrial property. The discussions at the Conference were sincere attempts to achieve this end, and the Conference assumed a further world-wide significance in view of the formation of the Economic Council of the United Nations Organisation.

SIXTH INTERNATIONAL CONGRESS OF EXPERIMENTAL CYTOLOGY

THE Sixth International Congress of Experimental Cytology met in Stockholm during July 10–17; some four hundred members from twenty-three countries attended. It was of outstanding interest in several ways. But for the War, this Sixth Congress would have met in 1940 at Stockholm, so the international ties in this branch of science were here appropriately reformed. Secondly, the official scope of 'experimental cytology' has now been broadened. Under the late Prof. Rhoda Erdmann, research based on the tissue-culture technique had taken a central position in pre-war meetings. Now, with the shift of the centre of gravity towards sub-microscopical biology, topics at this Congress ranged in ascending orders of magnitude from that of the large molecule to the whole organ.

To cover so wide a field, it was necessary in part to organise the Congress in separate sections, and here great tribute is due to the organising committee, and particularly to the general secretary, Dr. H. Hyden, for the admirable way in which the programme was arranged and carried out. The main sessions of the Congress generally took the form of symposia, at which recent work in each field was presented, mainly by the leading figures therein from New and Old Worlds.

It was clear that there had disappeared one of the cleavages in pre-war biology, namely, that between the disciplines of biochemistry and microscopical investigation. The focal interest in the biological significance of the nucleic acids and the development of the technique of analysis by differential centrifugation have effectively contributed to bridge this gap.

The freedom with which different techniques are now being used in particular fields was well illustrated both by the papers on muscle proteins and in the microbiological sections. The results obtained by the different methods are by no means yet in complete agreement; but the interplay of the different points of view both in the papers and in discussion was of great interest.

The contribution of Swedish men of science to the success of the Congress was at least of equal importance to that of the membership. Laboratories in Stockholm, Uppsala and elsewhere were freely open to visitors. Although Prof. Caspersson's new institute is not yet ready, there was a superb demonstration in the form of a series of panels which adequately expounded the work of his school. It was an experience deep with meaning to see the progress in science of a small country that has escaped the direct wastage of war.

The social side of the Congress was further memorable. Members were the guests of the city of Stockholm in the magnificent town hall on the shore of Lake Malar, and also, some days later, of the Biochemical Industrial Concern of Kärnbolaget.

The Congress concluded with a business session which refounded an International Society for Cell Biology, at which plans were announced for new international journals, of which one for cytological topics is to be edited from Sweden.

ORGANISATION OF THE CAPILLARY CIRCULATION

WHILE it is obvious that the capillary circulation is subject to local physiological control, there is much difference of opinion as to how this is achieved. In particular, it is still undecided whether or not the capillaries exhibit independent contractility and, if so, whether this is due to the presence of special perivascular contractile cells. Hitherto the capillary bed has been regarded as a network of capillaries of uniform structure fed by arterioles and drained by venules. Recent work, however, particularly by R. Chambers and B. W. Zweifach, has shown that the capillary bed comprises several different types of vessels which can now be separately defined, and each of which plays a particular part in the total functional organisation of the capillary bed.

Chambers and Zweifach have recently summarized their findings (*Ann. New York Acad. Sci.*, **46**, 683; 1946). Their observations were principally made on the rat's mesentery; but a similar pattern was found in subcutaneous tissue and skeletal muscle. They find that each arteriole is connected to a venule by one rather long straight vessel, the 'central channel' or 'arteriovenous channel' (not to be confused with arteriovenous anastomoses). The true capillaries arise as lateral offshoots from the proximal part of the central channel, form anastomosing networks and drain into the distal part of the central channel and also directly into venules. The proximal part of the central channel is called the 'metarteriole'; it is provided with muscle, and together with the arteriole is responsible for vasomotor control of the total blood flow through the capillary bed. The distal part of the central channel is non-muscular. Abrupt lateral branches from the metarteriole lead to the capillary networks. These lateral branches are muscular for a short distance. The muscular part is termed the 'precapillary' and acts as a sphincter controlling the admission of blood to the network of true capillaries beyond.

While the tissues are in a resting state there is relative ischæmia, the precapillary sphincters are closed and the blood flow is confined to the central channel. During tissue activity there is hyperæmia, the sphincters are open and blood flows through the whole capillary network. The true capillaries seem to exhibit no active vasomotor changes, their walls contain no adventitial contractile cells, neither do

the endothelial cells themselves undergo active contractile changes in shape as has frequently been claimed.

This further analysis of the capillary bed, with its closer definition of the term 'capillary', may enable us to reconcile some of the conflicting views of previous workers. For example, those who claim to have seen independent contraction of capillaries may, in fact, have been observing metarterioles or precapillaries. Chambers and Zweifach have established their findings in the case of the rat's mesentery, and they regard this pattern as the basic arrangement in all mammalian tissues, subject to local modifications in detail to suit the requirements of particular tissues. The frog's web and bat's wing, which have been so exhaustively studied by others, do not show the central channel type of circulation and are therefore regarded as atypical. It is still far from proved, however, that the pattern found in the rat's mesentery is typical of the mammalian capillary circulation in general. It is not unlikely that further patterns of capillary circulation remain to be discovered.

ELECTRONIC EQUIPMENT AT THE ROYAL AIRCRAFT ESTABLISHMENT

VISITORS were recently invited by the Director of the Royal Aircraft Establishment to a demonstration of equipment developed by, or in conjunction with, the Establishment for the measurement of aircraft structural and power plant characteristics, both in the laboratory and in flight. Essentially, the equipment must convert the physical quantity being measured into a movement (unless the quantity itself involves a movement); convert the movement into the corresponding variation of an electrical parameter; and finally amplify and record the variation.

The pick-up gives either a change in electrical resistance, capacity, or inductance, or a small change of voltage generated either mechanically or piezo-electrically. The calibrating equipment displayed emphasized the importance of a full investigation of the factors controlling the dynamic performance of every type of pick-up, since there is an increasing demand for the accurate measurement of strains, pressures, and accelerations at high frequencies. Wire resistance strain gauges are now almost universally used for the measurement of a strain; condenser and piezo-electric pick-up units are preferred for the measurement of fluid pressure, especially at high frequency.

Resistance strain gauges are susceptible to spurious resistance changes, particularly important being those due to temperature and humidity changes such as occur in moving from ground-level to a high altitude. Using a temperature-compensating gauge in the circuit, temperature effects can be ignored, but the effect of a humidity change varies from gauge to gauge, so waterproofing of both the active and the compensating gauges is very important. A static strain of 10^{-4} can be measured using a standard type of gauge with a 'null' method and manual balancing of the bridge circuit, which takes about six seconds for each station. For more than 250 gauge positions, time is saved by automatic switching. High-speed rotary switching makes it possible to photograph in the laboratory up to 600 cathode ray tube records of steady signals in about five seconds, but further time is, of course, spent in preparing the results for examination. A pen-and-ink recording unit operated by the out-of-balance current takes ninety-six readings in about half a minute.

The resistance gauge has also been applied to determine acceleration, as the strain of a loaded thin-walled cylinder; pressure, as a strain due to the deformation of a diaphragm or thin-walled cylinder; and force, as the strain of a short hollow cylinder in axial compression. The measuring element is usually of beryllium copper, which has a high proportional limit and is remarkably free from hysteresis. Future development includes the finding of more suitable gauge materials for high-temperature work.

Other types of gauge indicate the deflexion of one plate of an electrical condenser, or cause variation in the inductance and losses of two coils when a separating diaphragm, a common core, or a surrounding copper ring is displaced. A piezo-electric pick-up for the measurement of blast pressure consists of two pairs of crystals and two pistons to which the pressure is applied. Generator type vibration pick-ups were exhibited, measuring the movement of a vibrating body with respect to a stationary magnet; but as yet it has been found difficult to design a small, robust vibration pick-up unit with an undamped natural frequency less than 5 cycles per second, so that, below about 20 c.p.s., frequency and phase errors cannot be neglected.

To change alternating variations in resistance, capacitance or inductance into corresponding voltage changes before amplification and recording, the pick-up usually forms one or more arms of an A.C. bridge, the impedance change modulating the carrier-voltage. The output may be amplified by a stable A.C. coupled amplifier which has only to deal with the frequency range determined by the modulation sidebands. The modulated signal is demodulated immediately before recording, preferably in a phase-sensitive demodulator which gives an output the sign or phase of which is directly related to the phase of the carrier voltage and so differentiates between increase and decrease of pick-up impedance.

Freedom from instability, distortion, and microphony, and adequate response to low-frequency signals are desirable characteristics of the amplifier. Fairly simple direct-coupled amplifiers of adequate stability and gain are in use on ground equipment. Six-channel units photographing 3½-in. cathode ray tubes are available with amplifiers of voltage gain 20,000 and frequency response zero to 10,000 cycles per second. An alternative to the bridge circuit for capacitance or inductance units is the frequency- or amplitude-modulation resonant circuit, using a carrier frequency of one megacycle per second or higher. Although more complicated, this type of circuit has the advantage that, since attenuation and phase distortion introduced in passing between the oscillator and discriminator are unimportant, much of the equipment can be placed to avoid microphony.

It is essential for rapid recording from a large number of stations and for determining phase relations to use multi-channel equipment for flight work. The restrictions imposed by flight conditions have caused much attention to be given to the simple and compact bifilar or coil type electromagnetic vibration galvanometers, although the galvanometer

is less robust and has a much lower limit—about 1,200 c.p.s.—to its usable frequency range than the cathode ray tube. 4, 6, and 12-way flight units with either cathode ray tubes or galvanometers retain photographic recording, despite the additional labour and complication. Direct recording is being developed, but the increased inertia when using a stylus has reduced the frequency range of the existing four-way galvo-pen recorder to from zero to 70 c.p.s.

The cameras used have been designed for ready observation of faults, and incorporate means for exposing automatically a predetermined length of film, cutting or perforating between records, and record numbering; they give an accurate and convenient time scale and one or more reference lines on the paper parallel to its direction of motion. Daylight and rapid or mechanical reloading are often required for flight work.

Other exhibits included a torque-meter which measures the angular twist of a shaft in terms of the phase displacement between the E.M.F.s of two identical A.C. generators fixed at a known distance apart on the shaft, and a vacuum tube acceleration pick-up in which the two anodes of a double diode valve are elastically mounted and move with respect to the cathode under impressed acceleration.

The lucid account of recent work, given to visitors in papers written by E. Jones, J. Taylor, J. B. B. Owen, Dr. J. R. Richards, and Dr. J. E. Bennett, of the Royal Aircraft Establishment, has been valuable in the preparation of these notes.

RELEASE OF INFORMATION ON ATOMIC ENERGY

IN *Nature* of March 22, 1947 (p. 411), a list was published of seventy-three reports on atomic energy and related subjects which had been released by the Ministry of Supply from the category of secret documents. This list of 'declassified' reports on atomic energy has now been augmented, and at the same time a change has been made in the method of making them available to the scientific public. Henceforth, copies will be sold by H.M. Stationery Office, P.O. Box 569, Cornwall House, London, S.E.1, to which application should be made for reports from either list. It will be necessary only to quote the B.D.D.A. number in the present list, but titles should be quoted in the case of the previous list unless the B.D.D.A. number is known. These reports are in the form of enlarged prints taken from micro-films, and the prices below are for these prints; as an alternative, films could be supplied if desired. The copyright of all such documents is vested in the Crown, and copies may not be made, nor extracts published, without permission from H.M. Stationery Office.

It is hoped that H.M. Stationery Office will also be in a position shortly to supply documents of American origin on atomic energy, and applications for these should be made to the address given above.

These arrangements do not affect the method by which Canadian documents are obtained from the Plans and Publications Section of the National Research Council, Ottawa (see *Nature*, **159**, 719; 1947).

The British documents newly declassified are as follows:

B.D.D.A. No.	Report No.	Title and Author(s)	Date	Price
74	Br. 195	Report on experimental work on fluorine production to May, 1939. Thomson, J. W.	June 8, 1939	10s. 8d.
75	Br. 50	Investigations on oxides of X*. Haworth, W. N.	Nov. 1941	1s. 4d.
76	Br. 257	A new method of investigating the angular distribution of high-energy neutrons scattered by protons. Feather, N.	March 27, 1942	4s. 0d.
77	Br. 37	The preparation of fluorine. Ferguson, J.	May 22, 1942	10s. 8d.
78	Br. 72	Capture cross-sections of N, Mg, S, Ca and Pb for thermal neutrons. Fenning, F. W., Seligman, H.	Nov. 1942	2s. 0d.
79	Br. 89	Note on the inelastic scattering of fast neutrons. Feather, N.	Nov. 14, 1942	3s. 4d.
80	Br. 310	Neutron-produced radioactivity in relation to the detection of high-energy neutrons: maximum sensitivity of a counter. Feather, N.	Nov. 26, 1942	2s. 0d.
81	MS. 13	Equilibrium time in a separation plant. Peierls, R.	—	8s. 0d.
82	MS. 15	Effect of a stationary layer of thickness δ in front of the diffusing membrane. Peierls, R.	—	8d.
83	MS. 17	Separating effect of a passage through capillary. Peierls, R.	—	2s. 0d.
84	MS. 21	Effect of boundary layer for swept membranes. Fuchs, K.	—	8s. 8d.
85	MS. 39	Clusius–Dickel device as gland. Peierls, R.	—	4s. 0d.
86	MS.P 2A (Revised version of MS.P.2)	Critical conditions in neutron multiplication. Pryce, M. H. L.	—	2s. 8d.
87	MS. 85	Effect of a scattering container on the critical radius and time constant. Fuchs, K.	—	£1
88	Br. 106	Preparation of metallic X* by electrolysis of the fused salts. Haworth, W. N.	—	1s. 4d.
89	Br. 199	The "Metalectric" furnace (with sketch). Tomlinson (Metalectric Co., Ltd.). Haworth, W. N.	—	2s. 0d.
90	MS. 88	Note on the compression at the diffuser entry in compressor I.Z.I. Friedlander, F. G.	recd. July 1943	6s. 0d.
91	Br. 393	Density of resonance neutrons in hydrogenous media near the source. Booker, D. V., Broda, E., Kowarski, L.	Jan. 1944	14s. 8d.
92	Br. 448	Receiving time and counting errors in discriminators and scaling units. Cranshaw, T. E.	Jan. 18, 1944	10s. 8d.
93	Br. 391	Distribution of slow neutrons in rarefied hydrogenous media. Kowarski, L., West, D.	Feb. 1944	16s. 8d.
94	Br. 469	The determination of X* in urine. A proposed modification and some notes on the method. Jones, A. G.	Aug. 3, 1944	2s. 8d.
95	MS. 115	A new method of determining the time constant of a sphere in a container. Wilson, A. H.	Aug. 16, 1944	6s. 0d.
96	BI. 68	Extraction of protactinium from a siliceous raw material. Broda, E., Wright P. K.	March 1946	2s. 0d.
97	MS. 12A (Revised version)	Separation of isotopes. Peierls, R., Fuchs, K.	Feb. 25, 1947	10s. 0d.
98	Br. 732a (Revised version of Br. 732)	The spectrographic analysis of uranium. Walsh, A.	March 1947	10s. 0d.

* Uranium.

FORTHCOMING EVENTS

Wednesday, October 1

PHYSICAL SOCIETY, COLOUR GROUP (in the Small Physics Lecture Theatre, Imperial College, Imperial Institute Road, London, S.W.7), at 3.30 p.m.—A Review and Discussion of the International Colour-Vision Conference held at Cambridge in July (to be opened by Mr. J. G. Holmes and Mr. R. G. Horner).

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (in the Chemical Society's Rooms, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Scientific Papers.

ROYAL STATISTICAL SOCIETY, INDUSTRIAL APPLICATIONS SECTION, BIRMINGHAM GROUP (in the Chamber of Commerce, 95 New Street, Birmingham 2), at 6.30 p.m.—Mr. F. A. Friday: "Economics Statistics".

Thursday, October 2

TEXTILE INSTITUTE, YORKSHIRE SECTION (at the Midland Hotel, Bradford), at 7 p.m.—Sir E. Raymond Streat: "Textile Problems of To-day".

TEXTILE INSTITUTE, BLACKBURN BRANCH (at the Electricity Showrooms, Darwen Street, Blackburn), at 7.15 p.m.—Mr. F. Millard: "The Properties of Nylon and its Processing from the Weaving Point of View".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. F. G. Donnan, F.R.S.: Ernst Julius Cohen Memorial Lecture.

Friday, October 3

PHYSICAL SOCIETY, OPTICAL GROUP (in the Physics Department of Imperial College, Imperial Institute Road, London, S.W.7), at 3.15 p.m.—Scientific Papers.

ROYAL STATISTICAL SOCIETY, INDUSTRIAL APPLICATIONS SECTION, LONDON GROUP (at the E.L.M.A., Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. A. S. Wharton: "The Organisation of a Market Research Department".

Saturday, October 4

INSTITUTE OF ECONOMIC ENGINEERING, MIDLAND REGION (at the Chamber of Commerce, Birmingham), at 2.30 p.m.—Mr. S. Walford: "Time Study Allowances".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (joint meeting with the BRISTOL and SOUTH-WESTERN SECTION, at University College, Southampton), at 5 p.m.—Scientific Film Display followed by Discussion on Local Activities.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURESHIP IN MECHANICAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (October 6).

PRINCIPAL of the new Dorset Agricultural and Horticultural Institute (Farm Institute) at Kingston Maurward, near Dorchester—The Clerk to the Town Council, County Hall, Dorchester (October 11).

PRINCIPAL OF THE PADIHAM TECHNICAL SCHOOL—The Divisional Education Officer, Education Office, Bank Chambers, Padiham, Burnley, Lancashire (October 11).

LECTURER IN ELECTRONICS and a DEMONSTRATOR IN ELECTRONICS—The Registrar, The College of Aeronautics, Cranfield, Bletchley, Bucks, quoting "Lecturer in Electronics" or "Demonstrator in Electronics" as appropriate (October 11).

HISTOLOGIST (with Honours Degree in Physiology) for research on the structure of the skin of cattle and other livestock, and a PHYSICIST (with Honours Degree in Physics) or a PHYSIOLOGIST (with Honours Degree in Physiology) for research concerned with the application of electronics to various physiological measurements—The Secretary, The Hannah Dairy Research Institute, Kirkhill, Ayr (October 15).

LECTURER IN PURE MATHEMATICS—The Registrar, King's College, Newcastle-upon-Tyne (October 18).

ASSISTANT CIVIL ENGINEERS required by Sanitary Engineering Branch of the Ministry of Works in London, Liverpool, Nottingham, Cambridge, Exeter and Birmingham—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting E.371/47A (October 25).

SCIENTIST (Grade III) for London Headquarters of the National Coal Board (general graduate scientific training and some experience in physiology or biology)—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting G.433/47A (October 25).

TEMPORARY POSTS as EXPERIMENTAL OFFICERS or ASSISTANT EXPERIMENTAL OFFICERS at the Atomic Research Establishment, Harwell, Didcot, Berks—Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting F.778/47A (October 25).

MECHANICAL AND ELECTRICAL ENGINEERS in the Ministry of Supply (approximately 100 vacancies)—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 1963 (October 31).

FISHERY OFFICERS—The Secretary, Ministry of Agriculture and Fisheries, 23–25 Soho Square, London, W.1 (October 31).

PRINCIPAL SCIENTIFIC OFFICER, SENIOR EXPERIMENTAL OFFICERS (2), and EXPERIMENTAL OFFICERS (6), in the Ministry of Agriculture and Fisheries for employment at the National Institute of Agricultural Engineering—The Secretary, Ministry of Agriculture and Fisheries, 23–25 Soho Square, London, W.1 (November 5).

PRINCIPAL SCIENTIFIC OFFICER IN THE AERODYNAMICS DEPARTMENT of the Royal Aircraft Establishment, South Farnborough, Hants—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2004 (November 6).

SENIOR PRINCIPAL SCIENTIFIC OFFICER at the Signals Research and Development Establishment of the Ministry of Supply at Christchurch, Hants—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2032 (November 8).

TEACHER OF BOTANY AND ZOOLOGY—The Principal, Norwood Technical Institute, Knight's Hill, London, S.E.27 (November 8).

SENIOR LECTURER IN PHYSICAL CHEMISTRY at the University of Melbourne—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1, or the Registrar, The University, Melbourne, Australia (November 15).

SENIOR LECTURER IN METALLURGY at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (November 17).

SENIOR LECTURER IN ZOOLOGY at the University of Melbourne—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1, or the Registrar, The University, Melbourne, Australia (December 31).

MECHANICAL ENGINEERS (5) to instal and maintain various mechanical engineering projects, INSPECTORS (7) OF AGRICULTURE, and an INSPECTOR OF AGRICULTURE for agricultural educational duties, for the Department of Agriculture and Forests, Sudan Government—Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, marking envelopes "Cotton Engineer", "Agriculture Inspector" or "Agriculture Inspector (Education)" as appropriate.

FORECASTERS (3) are required for the Meteorological Station in Bermuda—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

ASSISTANT CIVIL ENGINEERS for the Directorate General of Works—Under-Secretary of State (8.2(b)), Air Ministry, Cornwall House, Stamford Street, London, S.E.1.

ASSISTANT PHYSICIST for duties in the X-ray and Radium Departments of the Royal Victoria Infirmary and other hospitals—The Town Clerk and Hon. Secretary of the Joint Cancer Committee, Town Hall, Newcastle-upon-Tyne.

LECTURER IN ZOOLOGY, and a LECTURER to teach BOTANY and ZOOLOGY or CHEMISTRY to Intermediate standard—The Registrar, Municipal College, Portsmouth.

SOIL LABORATORY ASSISTANT required by Government of Northern Rhodesia for Public Works Department—Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M/N/18398.

TEMPORARY ASSISTANT LECTURER IN MATHEMATICS—The Registrar, University College, Singleton Park, Swansea.

ASSISTANT LECTURER IN AGRICULTURAL BOTANY—The Registrar, The University, Reading.

INVESTIGATOR IN THE ANALYTICAL DEPARTMENT—The Secretary, The British Non-Ferrous Metals Research Association, 81–91 Euston Street, London, N.W.1.

JUNIOR ASSISTANT PHYSICIST at the Radiotherapy Centre, Scunthorpe—The Clerk of the Lincolnshire Joint Cancer Committee, County Offices, Lincoln.

JUNIOR PHYSICIST—Chief Physicist, British Scientific Instrument Research Association, Sira, Southill, Chislehurst, Kent.

PROFESSOR AND HEAD OF THE PHARMACOLOGY DEPARTMENT, and a HISTOLOGIST, an EMBRYOLOGIST and a NEUROANATOMIST for the Department of Anatomy—The Medical Secretary, Hebrew University, Jerusalem, Palestine.

TECHNICAL ASSISTANT FOR THE DEPARTMENT OF GEOLOGY—The Registrar, University College, Nottingham.

TEACHER OF ENGINEERING SUBJECTS—The Principal, Beckenham Technical Institute, Beckenham Road, Beckenham, Kent.

ASSISTANT MASTER with qualifications in Engineering or Chemistry for Worsley Technical School—Mr. A. B. Mills, Education Office, Town Hall, Swinton, Lancashire.

LABORATORY TECHNICIAN—The Secretary, University Hospital Medical School, University Street, London, W.C.1.

LECTURER IN ELECTRICAL ENGINEERING for Chance Technical College—The Chief Education Officer, 215 High Street, Smethwick, Staffs.

RESEARCH ASSISTANT IN PHARMACOLOGY (graduate in Physiology, Biochemistry or Medicine)—The Department of Pharmacology, University College London, Gower Street, W.C.1.

ENGINEERING ASSISTANT for Municipal Board of Mombasa, Kenya—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M/N/17958.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Other Countries

India Meteorological Department. Scientific Notes. Vol. 9, No. 101: Regression Formulae for Forecasting the Monsoon Rainfall in the Sub-divisions of Peninsular India. By V. Doraiswamy Iyer and V. Satakopan. Pp. 14 + 3 plates. 12 annas; 1s. Vol. 9, No. 102: A Discussion of Hourly Rainfall and Associated Wind Direction at Bangalore. By C. Sechachar. Pp. 15–28 + 4 plates. 5 annas; 6d. Vol. 9, No. 103: Sunshine at Rangoon. By S. B. Lal. Pp. 29–32. 5 annas; 6d. Vol. 9, No. 104: Diurnal Variation of Rainfall at Simla. By V. Doraiswamy Iyer and Mohammad Zafar. Pp. 33–36. 5 annas; 6d. Vol. 9, No. 105: Diurnal Variation of Rainfall at Mahabaleshwar. By V. Doraiswamy Iyer and Ishwar Dass. Pp. 37–42. 6 annas; 7d. (Delhi: Manager of Publications, 1946.) [183

Institut de France: Académie des Sciences. Annuaire pour 1946. Pp. 224. (Paris: Libr. Gauthier-Villars, 1946.) [183

Microwave: Pioneer Work in India Half a Century Ago. By Prof. S. K. Mitra. (Eighth Sir J. C. Bose Memorial Lecture.) Pp. 8. (Calcutta: Bose Research Institute, 1946.) [183

Bose Research Institute. Director's Report presented before the 28th Anniversary Meeting on the 30th November 1946. Pp. 9. (Calcutta: Bose Research Institute, 1946.) [183